TO STUDY OUTCOME OF INTERNAL FIXATION OF FRACTURE NECK OF FEMUR IN ADULTS

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I hereby declare that the thesis entitled "**TO STUDY OUTCOME OF INTERNAL FIXATION OF FRACTURE NECK OF FEMUR IN ADULTS.**" submitted towards partial fulfillment of the requirements for the award of **MS in ORTHOPEDICS** degree to BFUHS is a compilation of original work carried out by me under the supervision of Dr. Harpal Singh Selhi, Professor, Department of Orthopedics and Dr. Deepak Jain, Professor, Department of Orthopedics. No part of this thesis has formed the basis for the award of any degree previously.

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Dedicated

to

my Family

&

Teachers

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Dr. Udit Kumar

LIST OF ABBREVIATIONS

AP	-	ANTEROPOSTERIOR
AVN	-	AVASCULAR NECROSIS
CCS	-	CANCELLOUS CANNULATED SCREW
COVID	-	CORONA VIRUS DISEASE
CTI	-	CORTICAL THICKNESS INDEX
CT	-	COMPUTED TOMOGRAPHY
DHS	-	DYNAMIC HIP SCREW
DCLS	-	DYNAMIC COMPRESSION LOCKING SYSTEM
DM II	-	DIABETES MELLITUS TYPE II
FAITH	-	FIXATION USING ALTERNATIVE IMPLANTS FOR THE TREATMENT OF HIP FRACTURES
HHS	-	HARRIS HIP SCREW
MCCS	-	MULTIPLE CANNULATED COMPRESSION SCREWS
NOF	-	NECK OF FEMUR
PRISMA	-	PREFERRED REPORTING ITEMS FOR SYSTEMATIC REVIEWS AND META-ANALYSES
RCT	-	RANDOMISED CONTROLLED TRIAL
RTA	-	ROAD TRAFFIC ACCIDENT
SF 36	-	SHORT FORM HEALTH QUESTIONNAIRE 36
SP	-	SMITH PETERSON
THA	-	TOTAL HIP ARTHROPLASTY
TCD	-	TIP-CAPUT DISTANCE

ABSTRACT

Introduction: Femoral neck fractures in patients 50 years of age or younger are challenging injuries to treat because of the high-energy trauma mechanisms and the displaced fracture patterns typically found in this patient population. These fractures can be managed with a variety of treatment options ranging from internal fixation to arthroplasty. Due to frequent injury to blood supply of femoral head and various other anatomic considerations, no treatment modality gives good results in all patients. This study aims to evaluate union time, functional outcome and complications of internal fixation of femoral neck fractures amongst young adults.

Material and Methods: From May 2019 to November 2020, 18 patients of femoral neck fracture treated with internal fixation in our hospital were included in this study and were prospectively followed up for a period of 6 months. Functional outcome was measured with modified Harris Hip Score.

Results: Total 18 patients, with the mean ± standard deviation (SD) of age was 37.94 ± 10.64 years. 44.4% patient had undisplaced fractures (garden I & II) while 55.5% had displaced fractures (garden III & IV). 72.2% patients were operated within 24 hours of trauma while 27.8% patients were operated after 24 hours of trauma. 38.9% had anatomical reduction, 33.3% had negative buttress reduction and 27.7% had positive buttress reduction. 33.3% had excellent, 38.9% had good, 11.1% had reasonable while 16.7% had poor functional outcome. All patients with poor functional outcome belonged to displaced group and negative buttress group. Rate of AVN and non-union was higher amongst those operated beyond 24 hours as compared to overall rate of AVN and non-union in our study; similarly rate of non-union was higher amongst those with negative buttress reduction.

Conclusion: Internal fixation of femoral neck fracture has satisfactory results with good functional outcome amongst majority of the patients. It has several advantages over other methods of fixation especially in young patients as it is less invasive and biological environment of the fracture is maintained. Timely and proactive intervention, anatomic or positive buttress reduction, younger age group and undisplaced fracture have positive impact on outcome. Non-union, and avascular necrosis are some of the common complications and can lead to secondary procedures.

Keywords: femoral neck fractures, outcome, young adults, internal fixation, type of reduction, modified Harris hip score.

TABLE OF CONTENTS

S. NO.	TOPIC	PAGES
I	INTRODUCTION	1-6
II	AIMS AND OBJECTIVES	7
III	REVIEW OF LITERATURE	8-30
IV	MATERIALS AND METHODS	31-32
V	OBSERVATIONS AND RESULTS	33-71
VI	DISCUSSION	72-82
VII	SUMMARY AND CONCLUSIONS	83-85
VIII	BIBLIOGRAPHY	86-97
	APPENDICES – I - PROFORMA - MASTER CHART	
	APPENDICES – II - APPROVAL LETTER OF THESIS PLAN - THESIS PLAN	

LIST OF TABLES

Table No.	Title	Page No.
1.	AGE DISTRIBUTION	33
2.	SEX DISTRIBUTION	34
3.	SIDE DISTRIBUTION	35
4.	DISTRIBUTION OF ASSOCIATED COMORBIDITIES	36
5.	DISTRIBUTION OF PERSONAL HABITS	37
6.	MECHANISM OF INJURY	38
7.	LOCATION OF FRACTURE	39
8.	CLASSIFICATION OF FRACTURE (GARDEN'S GRADE)	40
9.	CLASSIFICATION OF FRACTURE (PAUWELS TYPE)	41
10.	REDUCTION METHOD	42
11.	NUMBER OF SCREWS	43
12.	ARRANGEMENT OF SCREWS	44
13.	REDUCTION ADEQUACY (REVERSE S SIGN)	45
14.	TYPE OF REDUCTION	46
15A.	REDUCTION ADEQUACY (GARDEN ALIGNMENT INDEX, AP VIEW)	47
15B.	REDUCTION ADEQUACY (GARDEN ALIGNMENT INDEX, LATERAL VIEW)	47
16.	TIME TO SURGERY	48
17.	TIME TO UNION	49
18.	FUNCTIONAL OUTCOME (BASED ON MODIFIED HARRIS HIP SCORE)	50
19.	RADIOLOGICAL OUTCOME	51
20.	COMPLICATIONS	52
21.	SECONDARY PROCEDURE	53
22.	CORRELATION OF AGE AT THE TIME OF FRACTURE WITH FUNCTIONAL OUTCOME	54
23.	CORRELATION OF MECHANISM OF INJURY WITH FUNCTIONAL OUTCOME	55

24.	CORRELATION OF FRACTURE DISPLACEMENT WITH FUNCTIONAL OUTCOME	56
25.	CORRELATION OF LOCATION OF FRACTURE WITH FUNCTIONAL OUTCOME	57
26.	CORRELATION OF TYPE OF REDUCTION WITH FUNCTIONAL OUTCOME	58
27.	CORRELATION OF TIME TO SURGERY WITH FUNCTIONAL OUTCOME	60
28.	CORRELATION OF RADIOLOGICAL OUTCOME WITH FUNCTIONAL OUTCOME	61
29.	CORRELATION OF ASSOCIATED COMORBIDITIES WITH FUNCTIONAL OUTCOME	62
30.	CORRELATION OF AGE GROUP WITH COMPLICATION	63
31.	CORRELATION OF COMPLICATIONS WITH REDUCTION ADEQUACY	64
32.	CORRELATION OF TIME TO SURGERY WITH COMPLICATIONS	65
33.	CORRELATION OF FRACTURE GRADE WITH COMPLICATIONS	66
34.	CORRELATION OF TYPE OF REDUCTION WITH COMPLICATION	67
35.	CORRELATION OF RADIOLOGICAL OUTCOME WITH AGE GROUP	68
36.	CORRELATION OF RADIOLOGICAL OUTCOME WITH DISPLACEMENT OF FRACTURE	69
37.	CORRELATION OF RADIOLOGICAL OUTCOME WITH TIME TO SURGERY	70
38.	CORRELATION OF RADIOLOGICAL OUTCOME WITH TYPE OF REDUCTION	71

LIST OF FIGURES

Fig. No.	Title	Page No.
1.	AGE DISTRIBUTION	33
2.	SEX DISTRIBUTION	34
3.	SIDE DISTRIBUTION	35
4.	DISTRIBUTION OF ASSOCIATED COMORBIDITIES	36
5A.	DISTRIBUTION OF PERSONAL HABITS (ALCOHOL)	37
5B.	DISTRIBUTION OF PERSONAL HABITS (SMOKING)	37
6.	MECHANISM OF INJURY	38
7.	LOCATION OF FRACTURE	39
8.	CLASSIFICATION OF FRACTURE (GARDEN'S GRADE)	40
9.	CLASSIFICATION OF FRACTURE (PAUWELS TYPE)	41
10.	REDUCTION METHOD	42
11.	NUMBER OF SCREWS	43
12.	ARRANGEMENT OF SCREWS	44
13.	REDUCTION ADEQUACY (REVERSE S SIGN)	45
14.	TYPE OF REDUCTION	46
15.	TIME TO SURGERY	48
16.	TIME TO UNION	49
17.	FUNCTIONAL OUTCOME (BASED ON MODIFIED HARRIS HIP SCORE)	50
18.	RADIOLOGICAL OUTCOME	51
19.	COMPLICATIONS	52
20.	SECONDARY PROCEDURE	53
21.	CORRELATION OF AGE AT THE TIME OF FRACTURE WITH FUNCTIONAL OUTCOME	54
22.	CORRELATION OF MECHANISM OF INJURY WITH FUNCTIONAL OUTCOME	55
23.	CORRELATION OF FRACTURE DISPLACEMENT WITH FUNCTIONAL OUTCOME	56
24.	CORRELATION OF LOCATION OF FRACTURE WITH FUNCTIONAL OUTCOME	57

25.	CORRELATION OF TYPE OF REDUCTION WITH FUNCTIONAL OUTCOME	58
26.	CORRELATION OF TIME TO SURGERY WITH FUNCTIONAL OUTCOME	60
27.	CORRELATION OF RADIOLOGICAL OUTCOME WITH FUNCTIONAL OUTCOME	61
28.	CORRELATION OF ASSOCIATED COMORBIDITIES WITH FUNCTIONAL OUTCOME	62
29.	CORRELATION OF AGE GROUP WITH COMPLICATION	63
30.	CORRELATION OF COMPLICATIONS WITH REDUCTION ADEQUACY	64
31.	CORRELATION OF TIME TO SURGERY WITH COMPLICATIONS	65
32.	CORRELATION OF FRACTURE GRADE WITH COMPLICATIONS	66
33.	CORRELATION OF TYPE OF REDUCTION WITH COMPLICATION	67
34.	CORRELATION OF RADIOLOGICAL OUTCOME WITH AGE GROUP	68
35.	CORRELATION OF RADIOLOGICAL OUTCOME WITH DISPLACEMENT OF FRACTURE	69
36.	CORRELATION OF RADIOLOGICAL OUTCOME WITH TIME TO SURGERY	70
37.	CORRELATION OF RADIOLOGICAL OUTCOME WITH TYPE OF REDUCTION	71

LIST OF PICTURES

Pic. No.	Title
1.	RADIOGRAPHS SHOWING (A) ANATOMICAL REDUCTION, (B) POSITIVE BUTTRESS REDUCTION AND (C) NEGATIVE BUTTRESS REDUCTION
2.	PREOPERATIVE AP VIEW AND LATERAL VIEW
3.	POST-OPERATIVE AP VIEW AND LATERAL VIEW WITH POSITIVE BUTTRESS REDUCTION
4.	AT 4 WEEKS FOLLOW UP - AP VIEW AND LATERAL VIEW
5.	AT 3 MONTHS FOLLOW UP - AP VIEW AND LATERAL VIEW
6.	AT 6 MONTHS FOLLOW UP - AP VIEW AND LATERAL VIEW SHOWING UNION AND SCREW BACKOUT
7.	AT 6 MONTHS FOLLOW UP – SQUATTING AND CROSSED LEG SITTING
8.	PREOPERATIVE AP VIEW
9.	POST-OPERATIVE AP AND LATERAL VIEW WITH ANATOMICAL REDUCTION
10.	AT 4 WEEKS FOLLOW UP - AP AND LATERAL VIEW
11.	AT 3 MONTHS FOLLOW UP - AP AND LATERAL VIEW SHOWING UNION
12.	AT 6 MONTHS FOLLOW UP - AP AND LATERAL VIEW SHOWING SIGNS OF AVN
13.	AT 6 MONTHS FOLLOW UP – SQUATTING AND CROSSED LEG SITTING
14.	PREOPERATIVE AP VIEW AND LATERAL VIEW
15.	POST-OPERATIVE AP AND LATERAL VIEW
16.	AT 3 MONTHS FOLLOW UP - AP AND LATERAL VIEW
17.	AT 6 MONTHS FOLLOW UP - AP AND LATERAL VIEW SHOWING UNION AND SIGNS OF AVN
18.	AT 6 MONTHS FOLLOW UP – SQUATTING AND CROSSED LEG SITTING

19.	PREOPERATIVE AP VIEW
20.	POST-OPERATIVE AP AND LATERAL VIEW SHOWING VALGUS IMPACTED FRACTURE WITH INSITU PINNING
21.	AT ONE MONTH, AP AND LATERAL VIEW
22.	AT 3 MONTHS FOLLOW UP - AP AND LATERAL VIEW SHOWING UNION
23.	AT 6 MONTHS FOLLOW UP - AP AND LATERAL VIEW
24.	AT 6 MONTHS FOLLOW UP – SQUATTING AND CROSSED LEG SITTING

INTRODUCTION

Hip fractures are common, and constitute 20% of the operative orthopaedic trauma workload.[1] Intracapsular femoral neck fractures account for over 50% of all hip fractures.[2]

Femoral Neck fractures in patients less than 50 years account for less than 5% of all hip fractures.[3]

The lifetime risk of sustaining a hip fracture is high and lies within the range of 40% to 50% in women and 13% to 22% in men. Life expectancy is increasing worldwide, and this demographic change can be expected to cause the number of hip fractures occurring worldwide to increase from 1.66 million in 1990 to 6.26 million in 2050.[4] It is often a fracture of fragility due to osteoporosis in the elderly, though in the younger age group, it usually results from high-energy trauma.[5]

The blood supply to the femoral head is tenuous and easily injured in the setting of displaced fractures. The primary supply to the weight-bearing portion of the femoral head is the lateral epiphyseal branch of the medial femoral circumflex artery. The medial femoral circumflex artery supplies 82% of the femoral head and 67% of the femoral neck. The lateral femoral circumflex artery contributes 18% of the vascularity to the femoral head and 33% to the neck, however, it supplies 48% to the anteroinferior femoral neck.[6]

Femoral neck fractures can be classified as subcapital, transcervical, or basicervical fractures. Subcapital femoral neck fractures in young adults between 15 and 50 years of age were found to have the highest combined complication rate of non-union and avascular necrosis (83%) compared to the transcervical femoral neck fracture group (21%).[7] Such fractures through the terminal end of the retinacular vessels can more likely lead to irreversible ischemia to the femoral head.

The most descriptive classification used for femoral neck fractures in young patients is the Pauwels classification. As the degree of the femoral neck fracture line relative to the horizontal plane increases, the types differ (<30 degrees type I, between 30 degrees and 50 degrees type II, >50 degrees type III), and the instability of the fracture.[8] Type III

fractures are associated with increased risks of fixation failure, osteonecrosis, and malunion or non-union.[9-12]

Garden (1961 and 1964) based his classification on the displacement of fractures as seen on the anteroposterior radiograph. He distinguished between fractures in valgus (Garden-I), without displacement (Garden-II), with slight displacement in varus (with fracture surfaces partly in contact) (Garden-III) and with complete displacement (Garden-IV).[13]

Unfortunately, like many other orthopaedic radiologic classifications, inter-observer and intra-observer levels of agreement are not ideal in garden classification. Also, criticism of the classification is the small number of cases fulfilling the criteria for Garden II fractures.[14]

Femoral neck fractures are intra-synovial, and the periosteum lacks a cambium layer. In diaphyseal fractures, a hematoma is encapsulated within the periosteum, and the cambium layer of the periosteum supplies pluripotent cells, which promote callus formation.[15]

In intracapsular fractures, there is a decreased supply of pluripotent cells, and the fracture hematoma is constantly lavaged away by synovial fluid. Thus, secondary fracture healing is not promoted. This type of bone healing requires an anatomic reduction and compression. Primary healing may occur if there is a small gap in a process known as gap healing. However, the high shear stress environment of femoral neck fractures is minimally forgiving.[16]

Even in undisplaced fracture neck of femur, there is no assurance that a fracture will attain an excellent outcome.[3] 10% to 15% of these patients will develop complications over which the surgeon has little or no control.[17] Moreover successful union with conservative management is uncommon. So, operative intervention has become the standard of care for all types of femoral neck fractures.[18]

It is advocated that fracture reduction and fixation should be performed as a surgical emergency in an attempt to restore the precarious blood supply to the femoral head and prevent complications such as non-union and avascular necrosis.[19-21]

Operative management of fracture neck of femur in young adults consists of fracture reduction and stabilization, has become the treatment of choice for many femoral neck fractures. Further, operative management permits early patient mobilization and minimizes many of the complications of prolonged bed rest. The options available for the stabilization of femoral neck fractures include Internal fixation using cannulated cancellous screws or sliding hip screw, hemiarthroplasty and total hip replacement.[22]

Younger high demand patients are not arthroplasty candidates, and thus preservation of the native hip joint is paramount. Surgeons are often faced with a disadvantaged biological environment with the combination of a displaced, vertical, intracapsular fracture.[23]

Goal for surgical treatment of femoral neck fractures in young patients is achieving union through an anatomic reduction and stable fixation while avoiding osteonecrosis.[24] Fixation with cannulated cancellous screws is usually adequate for femoral neck fractures. The conflict between the need for absolute anatomical reduction and at the same time, desire for tissue preservation has been going on for a long time. Not just solid healing, but immediate and continuous function of the limb is now a leading goal. However, precise reduction and absolute stable fixation has its biological price.[25] There has been evidence showing the superiority of biological fixation over a stable mechanical fixation.[26]

Performing multiple reductions or open reductions in pursuit of anatomical reduction may damage the blood supply of the site and then increase the risk of postoperative complications.[27,28]

Gotfried et al.[29] proposed a nonanatomic reduction method called the “Gotfried reduction.” Positive buttress position reduction which was defined as the distal fracture segment located inferiorly-medially to the lower-lateral part of the proximal fracture segment on AP radiographs, and negative buttress position reduction was defined as the distal fracture segment located superiorly-medially to lower-lateral part of the proximal fracture segment on AP radiographs.

PICTURE 1. RADIOGRAPHS SHOWING (A) ANATOMICAL REDUCTION, (B) POSITIVE BUTTRESS REDUCTION AND (C) NEGATIVE BUTTRESS REDUCTION[29]

The obvious goal in treating these fractures is the same as all fracture care: minimization of complications with return to maximal function. Although there are several opinions on the “optimum” treatment strategy for this injury, there is very little quality supportive evidence to help define the “gold standard” treatment, as is the case with many other fracture

patterns. The distinction between “young” and “old” is important and each carries a set of treatment ideology, strategy, and differing outcomes.

A 2014 report of a survey of the Orthopaedic Trauma Association’s Membership revealed that a consensus on the treatment of femoral neck fractures in young patients remains elusive.[30] Cannulated screws were used 43% versus a sliding hip screw with or without an anti-rotation screw (47%). Three parallel cancellous lag screws placed in an inverted triangle perpendicular to the fracture is the primary goal in treating most femoral neck fractures.[31]

On the other hand, prosthetic replacement is more common in patients with displaced fractures, older than 65 years of age, associated with poor health, neurological disease and osteopenic bone.[20,32]

Regardless of fixation construct used for femoral neck fractures, preserving femoral neck length can be difficult. In particular, fractures treated with partially threaded cannulated screws, while progressing towards union, often settle and heal with a shortened femoral neck disrupting neck–shaft offset and functional hip abductors and is associated with lower quality of life and increased revision rates.[33,-36]

Time to surgery remains controversial. Advantages of early surgery include unkinking vessels via urgent reduction and an intracapsular decompression both intended to improve perfusion of the femoral head and reduce the risk of osteonecrosis.[37-39]

There are studies suggesting need for urgent fixation as delayed treatment was associated with increased risk of avascular osteonecrosis.[40-42]

However, at the same time few studies suggest no major difference between those operated before and after 24 hours of surgery. Consensus as of now remains regarding operative treatment once patient is medically stable and surgical team is best able to achieve anatomical reduction.[20,32]

There is difference between outcome of displaced and un-displaced femoral neck fractures treated by fixation. Studies have found higher incidence of post operative complications amongst un-displaced as

compared to the displaced fractures. Overall rate for malunion, implant failure and need for reoperation was found to be 7.1%, 9.7% and 20% respectively.[20,32,43-46] While the reported rate of complications such as osteonecrosis of femoral head and fracture non-union, was 11%– 86% and 16%–59%, respectively.[47-49]

Non-union and avascular necrosis predisposes to future degenerative arthritis of the hip joint involved. Revision surgery or conversion surgery to hip replacement is reported to be between 20-6%.[50,51]

Because of these reasons, these intracapsular fractures of the neck of femur are an enigma to orthopaedic surgeons and it is a curse for an individual. It remains an “unsolved fracture” as results are far from ideal in modern day’s orthopaedics. As the population become proportionally more elderly there is an increased incidence of femoral neck fractures which constitutes a major socioeconomic problem. The treatment of these fractures remains a major challenge in modern orthopaedics.[40,52]

There are still several controversies surrounding the treatment of high-energy femoral neck fractures in young patients, namely, time to surgery, surgical approach, and optimal fixation. Until more conclusive data are available, an urgent open reduction and internal fixation, with the most appropriate surgical approach, best enables obtaining an anatomic reduction and optimizes femoral head perfusion. Regarding optimal fixation, surgeon experience and purposeful implant selection towards desired fixation goals as dictated by the fracture pattern and patient characteristics are critical to achieving successful union and outcomes.

We conducted a study to evaluate the outcome of cannulated screw fixation for femoral neck fracture in young patients in our institution. Special attention was given to the time lapse from injury to surgery in relation to union, quality of reduction and occurrence of complications such as avascular necrosis and non-union. The aims were to determine if there was any difference between early surgical fixation (less than 24 hours) and delayed fixation (24 hours and more), the prognostic factors for occurrence of avascular necrosis and finally the conversion rate to hip replacement in our patients who eventually developed complications.

AIMS AND OBJECTIVES

- To evaluate functional outcome of operatively managed fracture neck of femur with closed reduction and internal fixation with cannulated cancellous screw in young Indian adults using modified Harris hip score.
- To study the complications of operative fixation of fracture neck of femur using cannulated cancellous screw.

REVIEW OF LITERATURE

Femoral neck fracture has been recognised since the time of Hippocrates (460-377 BC). The first description of hip fractures was by a French Surgeon Ambrose Pare in 1564. He did not clearly distinguish between a fracture and dislocation of hip.[53]

Sir Astley Cooper gave a clear description of fracture of the neck of femur and other fractures and dislocation about the hip.[54] In 1822, in his book titled “A treatise on dislocations and fractures of joints” he has clearly delineated the differences between intracapsular and extra capsular fractures. He believed that non-union of intracapsular fractures was due to loss of blood supply to the proximal fragment and most femoral neck fractures would eventually heal with a fibrous union and that such patients would suffer “permanent lameness”. He also noted that incomplete fractures would unite by ossification.[55]

Astley cooper advocated a regimen of bed rest with affected limb extended and supported by pillows until pain subsided, followed by mobilization with crutches and gradual weight bearing. He did post-mortem examination of patients who died after femoral neck fractures and found that none of the fractures were united by bone (ossific union).[56]

This fracture is commonly encountered in elder population after a trivial fall. However fracture neck of femur in adults younger than age 50 years are uncommon and often the result of high energy trauma.[3] They account for only 2-3 % of all femoral neck fractures.[49]

In 1866, Hamilton and Stimson explained the preferential treatment of internal fixation for fracture neck of femur, quoting surgeries performed by John Ray Burton in Philadelphia in 1834.[55]

Whitman and Leadbetter methods of closed reduction were important contributions to the conservative management. In 1902, Whitman advocated careful closed reduction under X-ray control followed by hip spica application. This produced a few satisfactory unions, but extremely high morbidity and mortality.[57]

The first effective method of internal fixation was introduced in 1931 by Smith Peterson and associates.[58]The triflanged nail now bears his name as S.P. Nail. When properly used, succeeds in preventing the rotation and with improved alloy constituted in the nail does not produce any tissue reaction. S-P Nail technique was simplified by the introduction of the cannulated nail by Johannson in 1932 and Westcott in 1934.[58] This allowed closed reduction and fixing the fracture over a guide pin using S-P nail. A side plate was added to the triflanged nail by Thornton in 1937. This ultimately led to the development of a solid nail plate by Jewett in 1941.

Moore in 1934 enlarged upon the multiple pin principle of Martin and starting with three pins gradually increased to five.[59] He continued to emphasize the need for impaction and devised a punch to accomplish this. Several Modifications have been used like multiple pins, wires, simple flanged nails, collapsible nails. But none of them so far has been universally successful under all circumstances.

In 1945, Virgin and MacAusland introduced Dynamic Compression Hip Screw (DHS).[58]

A prospective study was done by Barnes et al. in year 1964 named, “Subcapital fractures of the femur-a prospective review”. In this study, a long-term investigation of 1503 subcapital fractures of the femur treated by reduction and internal fixation was done. With 3 exceptions, union occurred in all Garden grade I and II and in 67% of III and only 14.5% of Grade IV fractures were united at the end of 6 months. In women, late segmental collapse was seen after union had occurred in 16% of Grade I and in 27.6% of Grade III and IV fractures. The study concluded that delay of up to 1 week before operation had no significant effect on the incidence of non-union or of late segmental collapse. The age and physical state of the patient, accuracy of reduction and security of fixation had the greatest influence on union.[60]

Arnold WD et al.[59], Eiskjaer S et al.[61], Garcia A et al.[62], Holmberg S et al.[63], Holmberg S et al.[64] and Hunter GA et al.[65] in different studies showed that prosthetic replacement is associated with a higher rate of morbidity and mortality than in internal fixation.

Deyerle et al. in 1980 found that multiple pins placed around the periphery of the femoral neck to compress the fracture provided rotatory stability, and he concluded that this method would improve osteosynthesis.[66]

Rubin et al. in 1981 designed a mechanical fracture model that was fixed with Knowles pins. They found that imperfect reduction of the fracture and comminution of the fragments increased the instability of the reduction.[67]

Most contemporary studies do not identify an association between time to surgery and development of AVN or non-union. Zetterberg et al. in 1982, suggested that the timing of surgery after injury was an important factor in influencing the outcome.[68]

Crowell et al. (1985), and Benterud et al. (1992), in separate studies on cadaveric femora, placed screws in different quadrants of the femoral heads and showed that the inferior portion of the femoral head consistently had significantly lower screw pull-out strength. These authors believed that the increased trabecular density of the central and superior quadrants of the femoral head provided better screw fixation. Placement of two or three screws in the inverted triangle and diamond patterns provides better fixation in the dense bone of the femoral head.[69,70]

Swiontkowski et al. in 1986 in a series of 27 patients belonging to a similar age group, achieved union of 100% when surgery was performed within eight hours of the injury. This high rate of union may have been influenced by the number (30%) of undisplaced Garden grade II fractures among their patients. However, 20% of the patients developed AVN.[38]

Swiontkowski et al. in 1987 also tested three, four, or five implants of six commonly used multiple-fixation devices, including 6.5-millimeter cancellous screws. They reported that neither bending nor torsional stiffness, when normalized to intact specimens, was significantly improved in femurs instrumented with four or five implants when compared with those instrumented with three Screws.[71]

Blair B et al. in 1994 showed that the preferred method of internal fixation with cannulated cancellous screws is that of an inverted triangle configuration of screw placement with first screw running along the calcar, second postero-superiorly along the neck of femur, and a third screw antero-superior as an additional support. This pattern also reduces the risk of stress fractures occurring at the level of lesser trochanter.[72]

Cserhati et al. in the year 1996 conducted a study named “Non-operative or operative treatment for undisplaced femoral neck fractures: a comparative study of 122 non-operative and 125 operatively treated cases”. Comprising of 247 undisplaced femoral neck fractures, of which 122 were primarily treated non-operatively, and 125 with primary operative stabilization. The length of hospitalization was 1 week shorter in the operatively treated group. Number of patient leaving hospital in walking condition where more in operative group i.e upto 2/3rd of operative group. They also noted early displacement (within 6 weeks) in 20 percent of non-operative group. However, there was no early displacement in the operatively treated group. Therefore, primary operative stabilization of undisplaced femoral neck fractures was recommended.[19] Internal fixation remains the treatment of choice for these fractures in all age groups, more so in displaced fractures in the younger patients, where preservation of the femoral head is the priority. Gautam VK et al. in 1998 in their series of 25 young adults with displaced femoral neck fractures; performed open reduction of fracture site through an anterior capsular incision and fixation with three cancellous screws. The comparison showed that in young adults, primary open reduction and internal fixation of femoral neck fractures can be recommended as the treatment of choice.[60] While Rogmark C et al. in 2002 recommended primary arthroplasty for displaced fractures of the neck of the femur in patients over 70 years of age.[73]

Krischak G et al. in 2003 performed a retrospective analysis of postoperative reduction result of 39 patients of femoral neck fractures with cancellous screw fixation. The goal of the study was to evaluate the relevance of reduction quality to clinical outcome. They concluded that

a non-anatomic reduction in varus angulation significantly increases the risk of healing failure and secondary redislocation of fracture.[74]

Itadera E et al. in 2003 carried out a study on all patients with intracapsular fracture neck of femur over a period of 2 years treated with osteosynthesis with AO 6.5mm cannulated cancellous screws and followed up for 24 months; they concluded that the treatment of choice for non-displaced fracture neck of femur is osteosynthesis. Displaced fractures that occur on the day of operation or the day before should be treated with osteosynthesis if they are the typical type. The rest of the displaced fractures should be considered for primary prosthetic replacement.[75]

Upadhyay et al. evaluated 92 patients less than 50 years old with femoral neck fractures and overall rate of AVN was found to be 16 % with no difference in treatment before or after 48 hours. It was found that internal fixation was equally effective within one week of injury. No difference was found in the functional results between 6 patients in whom radiographic evidence of avascular necrosis developed and those in whom it did not. In conclusion, avascular necrosis was associated with a delay of more than 48 hours before the fixation of intracapsular femoral neck fractures. Nonetheless, functional outcomes were similar between the early and delayed fixation groups at an average of 2 years follow up. This study suggests that there may be an advantage to early fixation of intracapsular femoral neck fractures in terms of reducing radiographic evidence of avascular necrosis, although function may not necessarily be affected in the first few years following injury.[32]

G A higgins et al. in 2004 concluded from there retrospective study on 251 patients that most important factors within the control of the surgeon that influence the rate of healing are adequate reduction and correct placement of the screws. The fracture was displaced in 114 (49.9%) and undisplaced in 117 (50.6%) patients. In this series the reduction was unsatisfactory in 40 (35%) cases of the displaced NOF fractures, and the screws were incorrectly positioned in 46 (40.4%) of the 114 displaced fractures compared with 11 (9.4%) of the 117 undisplaced fractures.

The rate of AVN was similar in both fracture types (10.3%-11%), but the rate of non-union was four times higher (2.6%-11.5%) in displaced subcapital fractures.[76]

Haidukewych et al did a study between 1975 and 2000, 83 femoral neck fractures in 82 consecutive patients who were between fifteen and fifty years old were treated with internal fixation. 73 fractures were followed until union, until conversion to hip arthroplasty, or for a minimum of two years; the mean duration of follow-up was 6.6 years. 51 of the 73 fractures were displaced, and 22 were nondisplaced. The results and complications of treatment were retrospectively reviewed, and the effects of fracture displacement, reduction quality, and capsular decompression on outcome were evaluated. 53 (73%) of the seventy-three fractures healed after one operation and were associated with no evidence of osteonecrosis of the femoral head. Osteonecrosis developed in 17 fractures (23%), and a non-union developed in 6 (8%). At the time of the final follow-up, patients had a conversion to a total hip arthroplasty because of osteonecrosis (11), non-union (1), or both (1). 5 (9.8%) of the 51 displaced fractures were associated with the development of non-union, and 14 (27%) were associated with the development of osteonecrosis. Three (14%) of the twenty-two nondisplaced fractures were associated with the development of osteonecrosis, and one (4.5%) was associated with the development of non-union. Eleven (24%) of the forty-six displaced fractures with a good to excellent reduction were associated with the development of osteonecrosis, and two (4%) were associated with the development of non-union. Four of the five displaced fractures with a fair or poor reduction were associated with the development of osteonecrosis, non-union, or both.[20]

The ten-year survival rate of the native femoral head free of conversion to total hip arthroplasty was 85%. Osteonecrosis was the main reason for conversion to total hip arthroplasty, but not all patients with osteonecrosis required further surgery. The results of treatment were influenced by fracture displacement and the quality of reduction.[20]

Gurusamy et al. in 2005 studied the placement of three screws within the femoral head and the degree of angulation of the screws in 395 patients with displaced fractures. The position of the screws on the anteroposterior radiograph had no relationship with non-union of the fracture. However, they found that a reduced spread of screws on the lateral view was associated with an increased risk of non-union of the fracture.[77]

Damany DS et al. in 2005 published a metanalyses of 18 studies including 564 fractures. There was a higher incidence of non-union and avascular necrosis following displaced than undisplaced fractures. Non-union occurred more frequently after open reduction than closed reduction. The difference in the incidence of non-union and avascular necrosis following early (<12h) or late (>12 h) surgery was not significant for either non-union or avascular necrosis. They concluded that **e**arly or open reduction of these fractures may not reduce the risk of non-union or avascular necrosis. They also suggested higher incidence of non-union following open reduction than closed reduction.[78]

Kemler et al. in 2007 studied 164 consecutive femoral neck fracture patients treated by internal fixation between 1996 and 2002, retrospectively. They were divided into successfully treated patients and failures (defined as the need for an arthroplasty following internal fixation) and were compared with regard to age, pretraumatic mobility, fracture dislocation, fracture angle, operative delay, operative duration and experience of the surgeon. The found no statistical difference between groups with regard to aforementioned variables in the results. They further emphasised that it is justified to consider internal fixation to be the treatment of choice in most femoral neck fractures. Only in the case of osteoporotic bone, comminution at the fracture site, or failure to reduce or fix the fracture adequately, internal fixation has no value. Finally, the concluded that patients in whom internal fixation of femoral neck fractures fails, cannot be discerned from successfully treated patients by preoperative variables.[79]

Femoral neck fractures remain a difficult clinical problem for orthopaedic surgeons. Attempting to conserve the femoral head often leads to

healing complications, while the more predictable prosthetic replacements are associated with poorer function and significant complications. The treatment of these fractures depends on age of the patient, fracture displacement, bone quality, timing of surgery and activity level of the patient. Displaced fractures in healthy, active patients are best treated by reduction and internal fixation. A good anatomic reduction is mandatory. Femoral neck fractures reduced anatomically are best fixed with three screws. There are however, complications unique to femoral neck fractures which are almost impossible to predict. Non-union and avascular necrosis are amongst the most prominent complications. The decision to proceed in the management of failed fixation is based on the careful consideration of various factors. In young patients revision internal fixation with cancellous or muscle pedicle bone grafting (vascularised bone graft) or an osteotomy results in useful outcome. In the year 2008, Dhar et al reported a case of non-union of the fracture of the neck of the femur, who refused additional procedures after his non-union, had been established. The patient consented to a regular follow up ensuring careful supervision. The fracture eventually healed at 32 months radiographically.[80]

Michael et al. in 2008 conducted an study in series of 56 patients with united fracture of the femoral neck treated with multiple cancellous screws to assess the incidence of femoral neck shortening quantitatively and qualitatively in patients. They analysed latest ap radiograph of the fracture hip compared with contralateral uninjured hip. The images were overlapped digitally after scanning them.

The shortening rate was 31% for undisplaced and 27% for displaced fractures. The average abductor moment arm shortening was 10 +/- 4 mm. The average femur length decrease was 8 +/- 5 mm. In all other patients, abductor moment arm as well as femur length measurements were within 3 mm of the contralateral side and considered not to be shortened. Patients with shortened fractures (8 of 13) had significantly lower Physical Functioning ($p = 0.01$) and Role Physical ($p = 0.04$) SF-36 sub scores. They concluded that shortening has a significant negative impact on physical functioning.[33]

Michael T et al. in 2009 recommended that in femoral neck fractures, non-union can be avoided by careful attention to reduction and hardware positioning.[81] Similarly, Thuan et al. in 2009 recommended achieving an anatomic reduction and stable internal fixation as imperative variables for achieving good results in internal fixation group. According to them other treatment variables, such as the role of capsulotomy, and the method of fixation remain debatable. They also stated that the variables like timing of the open reduction and internal fixation has debatable role in good functional outcome. Their concluding statement mentioned goals of treating femoral neck fractures should include early diagnosis, early surgery, anatomic reduction, capsular decompression, and stable internal fixation.[82]

Loizou et al. in 2009 did prospective study of 1023 patients who sustained an intracapsular hip fracture that was treated with internal fixation using contemporary methods. They found that the overall incidence of avascular necrosis (AVN) was 6.6%. AVN was less common for undisplaced (4.0%) than for displaced fractures (9.5%) and in men (4.9%) than women (11.4%) who had a displaced fracture. The incidence of AVN for those aged less than 60 years and who sustained a displaced fracture was 20.6%, compared to 12.5% for those aged 60–80 years and 2.5% for those aged more than 80 years. They concluded that there is an increased risk of AVN with younger age and in females with a displaced fracture. Again, no association was found between the incidence of AVN and the interval between injury to surgery.[83]

Kumar et al. in year 2009 conducted a study named “Fractures of the neck of the femur - treated with multiple cannulated screws in younger patients –a study Of 40 cases” in tertiary care centre in an Indian setup. Study was conducted with aim to verify the validity of internal fixation of fracture neck of femur in young adults <50 years of age with percutaneous multiple cannulated hip screw fixation. Out of 40 patients, 9 had complications (7 were non-union and 2 were AVN). 31 had the hip united. All the patients of Garden I & II variety headed for complete union without any complication. In 32 patients of Garden III & IV variety 9 patients had complications which make 28% which is quite significant.

Average time for union was 16 weeks. They had a non-union rate of 17.5%, union rate of 82.5% and AVN to be 5 %.[84]

Davidovitch et al. in 2010 reviewed available literature dealing with skeletally mature patients up to the age of 60 years. They concluded that femoral neck fractures occurring in patients under the age of 60 years present a perplexing problem. Timing, capsular decompression, and open versus closed reduction were previously identified as the most relevant variables influencing the outcome of these injuries. They found many opinions exist in the literature as to the optimal treatment, no consensus existed, and no accepted algorithm was formulated. After reviewing available literature. The most significant sequelae of this injury were AVN and fracture non-union. Non-union of femoral neck fractures are often successfully treated, whereas the treatment options for osteonecrosis are not as reliable, often resulting in a total hip arthroplasty.[85]

Karantana et al. in 2011 collected data from 6782 consecutive hip fractures and identified 327 fractures in 315 women aged ≤65 years. They reported on their demographic characteristics, treatment and outcome and compare them with a cohort of 4810 hip fractures in 4542 women aged > 65 years. It was the first study of its kind focusing solely on women population. They majorly concluded that the first significant increase in age-related incidence of hip fracture was at 45, rather than 50, which is when screening for the osteoporosis starts in most health areas. According to their cohort hip fractures in younger women were sustained by a population at risk as a result of underlying disease. Also mortality of younger women with hip fracture was 46 times the background mortality of the female population. They found smoking had a strong influence on the relative risk of 'early' (≤ 65 years of age) fracture. Lag screw fixation was the most common method of operative treatment. General complication rates were low, as were re-operation rates for cemented prostheses. Kaplan-Meier implant survivorship of displaced intracapsular fractures treated by reduction and lag screw fixation was 71% (95% confidence interval 56 to 81) at five years. Finally

they concluded that the best form of treatment still remains controversial as far as their study population is concerned.[86]

Schweitzer et al. in the year 2012 published the study to determine the factors associated with femoral head avascular necrosis and non-union in patients younger than 65 years with displaced femoral neck fractures treated with reduction and internal fixation. This was retrospective study which included 29 patients with displaced fracture neck of femur treated in a single institution. They evaluated influence of age, trauma energy, open reduction, and time from fracture to treatment on development of avascular necrosis and non-union. They found that patients who developed avascular necrosis were significantly older and suffered lower energy trauma than cases without avascular necrosis. No recorded variables were associated with non-union. Logistic regression determined that only age was independently associated with avascular necrosis. Age was a good predictor for developing avascular necrosis and a best cut-off determined at 53.5 years. They concluded that patients between 53.5 and 65 years presented a higher risk of avascular necrosis. They recommended primary arthroplasty in this subgroup.[87]

Rawall et al. in 2012 enrolled 27 consecutive patients with displaced fracture neck of femur suitable for osteosynthesis underwent closed reduction and fixation with three 6.5 mm cancellous cannulated screws. They studied posterior comminution and its extent (as seen on CT scan) and the intracapsular pressure difference between the fractured and the opposite side was kept in all the patients. The patients were followed-up for 1 year. The main outcomes measured at 1 year were non-union (as identified by CT scan) and AVN (as identified by bone scan). Cases with pressure difference >30 mm were found to have a higher rate of AVN and this result was found to be statistically significant (p value 0.034). The patients with significant posterior comminution were found to have higher non-union rates and this result was also found to be statistically significant (p value 0.04). Prognosis of displaced fracture neck of femur is significantly associated significant with posterior comminution and intracapsular pressure difference between fractured and normal side.[88]

There are several classification systems for femoral neck fracture of these most used are AO group, AO subgroup, gardens and pauwels. Gasper et al. in 2012 conducted a study entitled “AO group, AO subgroup, Garden and Pauwels classification systems of femoral neck fractures: are they reliable and reproducible?” to find reliable and reproducible classification system to predict a method of treatment, radiological prediction of nonunion and prediction of outcomes. They asked 5 observers to classify 77 randomly selected anteroposterior and lateral radiographs of fracture neck of femur based on these four classifications. They were again asked to classify same radiographs after 3 months. They found that Overall mean for classification system for interobserver agreement is: AO 0.44, AO subgroup 0.17, Garden 0.41 and Pauwels 0.19. Mean intraobserver agreement for AO group was 0.56, AO subgroup 0.38, Garden 0.49 and Pauwels 0.38 coefficient kappa value.

They concluded that Garden and AO group are useful for the division of femoral neck fractures without displacement and with displacement, but they are not for clinical use. AO subgroup and Pauwels classification are not recommended for further use.[89]

Cannulated screw fixation is a widely accepted surgical method for management of fractures of the neck of femur especially in patients with poor premorbid conditions, minimally displaced fractures and those from a younger age group. In year 2014, Khoo et al conducted a five-year retrospective study entitled, “Cannulated screw fixation for femoral neck fractures: A 5-year experience in single institution” in 53 consecutive patients between 2006 to 2010 to determine the pattern of injuries, management, outcomes and associated predictive factors. The fractures in all patients were analysed for displacement and stability, using Garden Classification and Pauwels Classification respectively. Garden’s Alignment Index was used to assess fracture reduction postoperatively, with 155° - 180° in both antero-posterior and lateral view as the criterion for adequate reduction. All the patients underwent cannulated screw fixation, with 37 (69.8%) having surgery within 24 hours and the remaining 16 (30.2%), 24 hours after the initial injury. All patients were

followed up to union of fractures and complications thereafter if any. Good outcome was observed in 43 (81.1%) patients leaving only 10 (18.9%) patients with a poor outcome, of whom 9 developed avascular necrosis (90%) and one non-union (10%).

No significant relationship was found between the incidence of avascular necrosis and age of patient, fracture displacement, number of cannulated screws used, fracture reduction acceptability and anatomical location of the fracture. The time interval from injury to surgery and the presence of posterior comminution did seem to influence the rate of avascular necrosis but due to the small number of patients, it was not statistically significant. Hence, it was concluded that cannulated screw fixation is a viable option of treatment for fracture of neck of femur.[5]

Another treatment option in the form of osteosynthesis and primary valgus intertrochanteric osteotomy using dynamic hip screw with side plate and a derotation screw was studied by Dwarkadas et al. in case series in 2014 entitled “Primary management of fracture of femoral neck in young adults using valgus osteotomy and fixation with dynamic hip screw and plate” In this study, 10 patients of recent (<3 weeks old) displaced intracapsular fracture neck femur (Garden III and IV, Pauwels III, with or without comminution) in the age group 20-40 years were subjected to osteosynthesis and primary valgus intertrochanteric osteotomy using dynamic hip screw with side plate and a derotation screw. Union at the fracture site was achieved in al (100 %) patients within 12 months of surgery. One case, which had undergone previous surgery with multiple screw fixation, developed avascular necrosis (10%). Repeat surgery rate was 10% (for patient with avascular necrosis) however, none of the patients required repeat surgery for achieving union. None of the 10 patients had poor outcome. All patients could sit cross legged and squat and were back to their previous jobs. Hence, it was concluded that the valgus osteotomy with DHS method is economical and readily available. It produces satisfactory results employing a device and instrumentation that is more familiar to orthopaedic surgeons. The technique is reproducible and has been used successfully in this series of 10 patients.[90]

Slobogean et al. in 2015 published a study to quantitatively pool the incidence of patient important complications following internal fixation of young femoral neck fractures. This meta-analysis included 1558 fractures from 41 studies. They found 18 percent rate of reoperation, rate of avascular necrosis being 14.3 percent and non-union was found to be in upto 9.3 percent cases. They found displaced fracture to be more likely to undergo reoperation and to result in avascular necrosis or non-union. They reported total incidence of malunion upto 7.1 percent, implant failure upto 9.7 percent and surgical site infection upto 5.1 percent. Complications associated with a femoral neck fracture treated in conjunction with an ipsilateral femoral shaft fracture were lower overall than the pooled estimates for isolated neck fractures.

Thus, they concluded that the incidence of complications experienced were more commonly present in young femoral neck fracture patients. Reoperation following internal fixation were most commonly associated with complication like avascular necrosis and non-union.[43]

Popelka et al. in the year 2015 conducted retrospective study collecting data of patients with intracapsular fracture of the femoral neck surgically treated from 2001 to 2011. The study reviewed 1555 patients treated for this fracture of which 125 underwent osteosynthesis. Out of 125, only 115 patients presented for examination at one year. 52 % were women and 48 % were men out of those who presented. Dynamic hip screw was implant of choice in 103 patients while 12 patients had cannulated screws employed. The patients were allocated to groups according to injury to surgery time interval and to subgroups on the basis of the garden classification of femoral fracture stage.

They found that out of 58 patients who were treated within 6 hours of injury avascular necrosis developed in 17% as compared 19 % of those who were operated between 6 hours to 24 hours post injury. Amongst those treated within 6 hours of injury frequency of avascular necrosis was more amongst displaced variant (garden stage 3 & 4) as compared to non-displaced variant (garden stage 1 & 2). Another subgroup which comprised of the patients treated after 24 hours of injury had risk of development of avascular necrosis as high as 44 %, the fracture stage

made no significant difference on the risk of development avascular necrosis similar to the findings of subgroup treated between 6 hours to 24 hours.

Finally, they concluded that lower AVN occurrence in the patients surgically treated within 24 h of injury. In the patients treated within 6 h of injury, AVN incidence was significantly lower in the patients with non-displaced fractures, as compared with those who had displaced fractures. This was not true for the two patient groups treated later (6-24 and later than 24 h) in which the differences between AVN development after non-displaced fractures and that after displaced fractures were similar.[91]

The optimal management of intracapsular fractures of the femoral neck in independently mobile patients remains open to debate. Successful fixation obviates the limitations of arthroplasty for this group of patients. However, with fixation failure rates as high as 30%, the outcome of revision surgery to salvage total hip arthroplasty (THA) must be considered. Mahmoud et al in the year 2016 published a PRISMA compliant systemic review highlighting this issue. Their analysis revealed significantly increased risk of complications including deep infection, early dislocation and peri-prosthetic fracture with salvage THA when compared with primary THA for an intracapsular fracture of the femoral neck (overall risk ratio of 3.15). However, no significant difference in the functional outcome was found between two groups.

They concluded that salvage THA carries a significantly higher risk of complications than primary THA for intracapsular fractured neck of femur. Further well-designed study was advised to provide full answer to the question.[92]

Kumar et al. conducted a study in year 2016 which intended to analyse the functional outcomes of femoral neck fractures in adults below 60 years of age, treated surgically by internal fixation following delayed presentation – more than 48 hours after trauma. 51 patients under the age of 60 years presenting with intracapsular femoral neck fracture between 2009 and 2014 were identified. Of these, 3 patients were treated with total hip replacement and 3 with bipolar hemiarthroplasty.

These patients were excluded from the study. No follow-up data was available for 5 patients, so these patients were also excluded from the data. Therefore, 40 patients under the age of 60 were included. Patients below 60 years of age with femur neck fractures who presented > 48 hours following trauma and treated by internal fixation, were included in the study.

All patients were examined to determine the development of avascular necrosis, and the rates of avascular necrosis were analysed with respect to potential predictor variables – age, fracture displacement, time to fracture reduction, and type of fixation (a sliding hip screw or three cannulated screws). All patients who could be contacted were asked to return for radiographic follow-up, and the development of avascular necrosis was determined on the most recent radiographs available. Preoperative and postoperative radiographs of the hip and pelvis were also evaluated for the quality of fracture reduction, adequacy of fixation, fracture-healing, and pre-existing avascular necrosis. Acceptability of fracture reduction was evaluated based on Garden's alignment index. All cases were fixed following closed reduction. 32 patients had a displaced fracture, with a mean time to surgery of 32.3 ± 14.5 hours. Patients had an undisplaced fracture, with a mean time to surgery of 40.9 ± 29.2 hours.

Four cases developed non-union, of which three later underwent total hip arthroplasty and one underwent hemiarthroplasty. The mean time to union in the remaining cases was 18 ± 2.4 weeks. In the series as a whole, avascular necrosis was seen in three cases; two of which were following fixation by sliding hip screw, and one following fixation with CC screws. Radiographic evidence of avascular necrosis developed in three (7.5%) of the entire group of forty patients. All three cases had displaced femoral neck fractures. With regard to the Harris Hip Score, 29 cases had excellent outcomes, 6 had good outcomes, 4 fair, and one patient had a poor functional HHS. No deaths, deep venous thromboses or wound infections were noted in the study group.[93]

Considering higher reoperation rate following fixation of hip fractures a study was warranted to study the effect of a sliding hip screw versus

cancellous screws on the risk of reoperation and other key outcomes . A study under the heading “Fixation using Alternative Implants for the Treatment of Hip fractures (FAITH) Investigators. Fracture fixation in the operative management of hip fractures (FAITH): an international, multicentre, randomised controlled trial” was published in the year 2017. This study compared use of sliding hip screws with cannulated screws for low energy hip fractures. They randomised 1108 patients to receive sliding hip screw (557) and cancellous screws (551). Reoperations within 24 months did not differ in two groups - 20 percent with sliding hip screws vs 22 percent with cancellous screws. Avascular necrosis was, more common in sliding hip screw group than cancellous screw group (9% vs 5%).

The authors found no significant difference between two groups on the basis of medical related adverse events. They finally concluded that sliding hip screw had no major advantage as compared to cancellous screw as far as reoperation rate is considered.[94]

Ye et al. in 2017 published a study suggesting novel method of internal fixation of vertically unstable fracture neck of femur by augmenting cannulated cancellous screws with medial buttress plate. They evaluated the outcome and complications of unstable Pauwels type 3 femoral neck fractures treated with a combination fixation of three cannulated screws and a medial buttress plate. They recruited 28 patients under 60 years of age with Pauwels type 3 femoral neck fracture who were treated with open reduction and internal fixation using a direct anterior approach fixed with three cannulated screws augmented with a medial buttress plate. All reductions were confirmed post operatively using gardens alignment index. After losing out one patient to follow up rest 27 patients were followed up at regular intervals for 12 months post operatively.

They found that union without shortening of neck was found in 89% of cases. However, Implant failure was found in three cases which included backing out of screws in two cases and breakage of screw and plate in one case. Adding to the positive results they found that there was no cases of avascular necrosis at mean follow up of 13.6 months.

Finally they concluded that cannulated screws combined with medial buttress plate improves the fracture union rate compared to historical series using cannulated screws alone in short term follow up and that this method did not cause any increase in implant related complications.[95]

Gumustas S et al. in 2018 recruited patients with femoral neck fractures undergone internal fixation by cancellous cannulated screw between 2010 and 2015. They divided cases into two groups one operated before 24 hours of the trauma and other operated 24 hours after the trauma. They were evaluated for AVN using radiological staging of Ficat and Arlet classification. Average duration from injury to surgery was 6.6 (1-20) days. Thirty nine percent of fractures was nondisplaced whereas 61% was displaced. The average follow-up period was 4.9 ± 1.35 years. The rate of non-union was found to be 16% and femoral head avascular necrosis was 6.4%. Cases who had displaced fractures statistically showed worse functional results and underwent more secondary surgery than patients with nondisplaced fractures. There were no significant differences between the two groups according to the surgical timing in terms of functional outcomes and complications.[96]

They concluded that surgical treatment of fracture neck of femur after 24 hours does not alter rate of complications as well as reoperation rates. They further recommended operating under optimal conditions and taking careful note of poor outcome in displaced fracture.[96]

Femoral neck shortening in the patients of fracture neck of femur post union has been a key factor in reduced quality of life and impaired gait pattern amongst patients. Weil et al in the year 2018 published a study entitled “Use of fully threaded cannulated screws decreases femoral neck shortening after fixation of femoral neck fractures”. They used fully threaded screw with or without partially threaded screw for fixation of fracture neck of femur. They recruited 38 patients operated between 2014 and 2016 managed with fully threaded screws. They did radiographs to observe femoral neck shortening in three vectors along horizontal, vertical and overall, according to neck shaft angle. They observed that average femoral neck shortening in the horizontal axis

was significantly smaller in the fully threaded screw group than in the partially threaded screw group. There was a tendency towards a more valgus reduction in the partially threaded screw group. There was a significantly smaller number of fully threaded screw patients with moderate (5-10 mm) or severe (> 10 mm) femoral neck shortening. Screw pull-out > 5 mm occurred in 17/41 patients in the partially threaded screw but none in the fully threaded screw group ($p < 0.01$).

They thus concluded that use of fully threaded screw improves the radiographic results following femoral neck fracture fixation using cannulated screws.[97]

Four cannulated screw in the diamond configuration was a novel configuration recommended by some of the authors after biomechanical studies in patients with posterior comminution. Rajnish RK et al. in 2019 conducted a study to evaluate efficiency of diamond configuration of cannulated screw. They conducted study on 25 consecutive patients taken over time period of 1 year. At the end of the study 20 patients were followed up for the average period of 33.3 months. Union of the fracture site and signs of AVN was looked for in the serial radiographs and functional outcome was evaluated by Harris hip score.

They found that 16 patients had achieved union, 2 had avascular necrosis and 2 had non-union. All patients with union had good functional outcome. They thus concluded that diamond configuration was reasonable in patients with intracapsular neck of femur fracture with comminution. They advised further studies to reach a definite conclusion.[98]

Over the year both sliding hip screw and cannulated cancellous screw have stood the taste of time to remain the preferable implant for internal fixation of intra-capsular fracture neck of femur in young adults. But there is paucity of data comparing sliding hip screw with cancellous cannulated screws on the basis of reoperation rate and clinical outcomes. Shehata et al. in the year 2019 published a metanalysis and systematic review to compare the same. Publications containing randomised controlled trial comparing sliding hip screw with cancellous cannulated screw were

chosen without any language or publication restriction. Ten RCTs involving 1934 patients were included in the final analysis. The variables for analysis included operative details, non-union rate, avascular necrosis, reoperation, infection and mortality, hip pain, functional hip scores, and medical complications.

They found sliding hip screw group was associated with more intraoperative blood loss as compared to cannulated cancellous screw. There was no significant difference in terms of operative time, postoperative hip function, non-union, avascular necrosis, reoperation rate, infection, fracture healing, hip pain, medical complications, and mortality rate.

Based on their study they concluded that cancellous screw group was associated with less blood loss. There was no other significant difference between two intervention.[99]

Shin et al. in 2019 did a retrospective study entitled “Three-dimensional analyses to predict surgical outcomes in non-displaced or valgus impaction fractures of the femoral neck” to report surgical outcome following internal fixation in valgus impacted and non-displaced cases of fracture femoral neck. They also studied probable radiological predictors for internal fixation failure as well as three-dimensional analysis of femoral fracture using radiographs and CT-scans. They included 64 patients with non-displaced or valgus impaction of femoral neck fracture who had undergone internal fixation with multiple cannulated screw. They tried to determine the independent variables to predict non-union, osteonecrosis and reoperation. Non-union was observed in 14% patients while 16% patient had osteonecrosis of femoral head post union. They found that low bone mineral density of the femur, a higher posterior tilt angle on translateral view, and a higher retroversion angle on axial CT images were independent predictors of non-union and re-operation.

They concluded that primary hip arthroplasty should be considered in elderly with posterior tilt of more than 9 degree of translateral view and retroversion of more that 13 degree on the axial view of CT-scan. At the

same time they advised primary arthroplasty in patients with low bone mineral density with valgus impaction.[100]

Currently, no internal fixation method is superior to other internal fixation methods in the treatment of femoral neck fractures. Therefore, the internal fixation system needs to be further explored. Ping shu et al. in 2020 published a study to compare two methods of internal fixation, femoral neck dynamic compression locking system (DCLS) and multiple cannulated compression screws (MCCS) in the treatment of femoral neck fractures. They included 54 patients with femoral neck fractures treated with either a DCLS ($n = 28$) or MCCS ($n = 26$) was conducted between December 2015 and November 2017 in authors' hospital. They were followed up 24 – 47 months. They found that there was no significant difference in follow-up time, operation time, incision length, surgical blood loss, the incidence of perioperative and postoperative healing complications, and mobility in the two groups. However, the Harris score, fracture healing time, femoral neck shortening, partial weight-bearing time and complete weight-bearing time were significantly better in the DCLS group than in the MCCS group (all $P < 0.05$). They found that fracture healing rate was better in DCLS group that in MCCS group.

Thus, they concluded that the DCLS and MCCS were equally effective in clinical outcomes like difference in follow-up time, operation time, incision length, surgical blood loss, the incidence of perioperative and postoperative healing complications, and mobility. However, DCLS is superior to MCCS in functional outcome, fracture healing time, femoral neck shortening, weight-bearing time and fracture healing rate.[101]

Though anatomical reduction has been single best predictor for clinical and functional outcome in femoral neck fracture patients post internal fixation but sometimes a balanced approach has to be maintained and non-anatomical reduction is achieved. Zhao et al. in 2021 published a study aimed at investigating association between different reduction classifications (anatomic reduction, positive buttress position reduction, and negative buttress position reduction) and two end points (complications and reoperations). They retrospectively studied 110

patients undergone internal fixation of fracture neck of femur with three parallel cannulated screws. They divided the patients into three groups based on the principle of the Gotfried reduction namely anatomical reduction, positive buttress position reduction and negative buttress reduction. Clinical characteristics including age, sex, side, Garden classification, Pauwels classification, fracture level, reduction classification, Garden alignment index angles, cortical thickness index (CTI), tip-caput distance (TCD), angle of the inferior screw, and the two ending points (complications and reoperations) were included in the statistical analysis. 41 patients showed anatomic reduction, 35 patients showed positive buttress position and 34 showed negative buttress reduction. After multivariate logistic regression of complications negative buttress reduction was found to be correlated with higher risk of complications and reoperations. They however found no significant difference between positive reduction and anatomical reduction in the analysis of complications not reoperations.

They thus concluded that positive buttress position reduction of femoral neck fractures in young patients showed a similar incidence of complications and reoperations compared with those of anatomic reduction. For non-reducing femoral neck fractures, if positive buttress position reduction has been achieved intraoperatively, it is not necessary to pursue anatomical reduction; however, negative reduction needs to be avoided.[102]

Similarly, Liu et al. in 2021 published an analysis of total 225 with unilateral femoral neck fracture followed up for an average of 4 years. According to quality of reduction the patients were divided into positive buttress reduction group, anatomical reduction group and negative buttress reduction group. Basic information such as injury mechanism, time from injury to surgery, Garden classification and Pauwels classification was collected, Harris scores were performed at 3 months, 6 months, and 12 months after surgery, and postoperative complications (femoral head necrosis, femoral neck shortening, and femoral neck non-union) were collected. They observed that there was no significant difference in Harris hip score at 6 and 12 months after operation among

three groups which was lower in negative buttress group. The incidence of osteonecrosis of femoral head was higher in negative buttress group as compared to other two groups. The incidence of femoral neck non-union and femoral neck shortening in the negative buttress group was also higher than that in the anatomical reduction and positive buttress group ($P < 0.05$). The results of finite element analysis showed that stress and fracture end displacement in the negative buttress group were greater than those in positive buttress group.

The conclusion was similar to previous study that both positive and anatomical reduction in the treatment of femoral neck fracture can achieve comparable and better clinical results and lower post-operative complications and that positive brace support and anatomic reduction can limit restoration of femoral stress conduction. Therefore, it is not necessary to pursue anatomical reduction too deliberately during surgery, while negative buttress reduction should be avoided.[103]

Anil et al in 2021 proposed a novel modified garden index to evaluate effect of anatomical reduction on functional outcome in femoral neck fracture. They included 26 patients who underwent internal fixation of fracture neck of femur with cannulated screws were studied retrospectively. Harris hip score of the patients at 9 and 12 months were evaluated using the new index modified from garden which is the sum of the differences from the ideal garden index calculated on early postoperative anteroposterior and lateral pelvic radiographs. They found inverse corelation between novel index and the Harris hip score.

They thus concluded that new reduction index proposed will contribute in better comparison of anatomical reduction in femoral neck fracture.[104]

MATERIALS AND METHODS

It was a prospective study, studying the outcomes in patients from a period of May 2019 to Nov 2020 with femoral neck fracture treated with internal fixation in the Department of Orthopaedics, Dayanand Medical College, Ludhiana. The study was carried out by taking an informed consent from the patients willing to be a part of the study. The variables studied were age of the patient, sex, associated comorbidities, fracture classification, location of fracture, adequacy of reduction, type of reduction, time to surgery, time to union and their relationship with functional, radiological outcome and complications.

INCLUSION CRITERIA-

All fractures involving the neck of femur in patients between the age group of 18 - 50 years undergoing internal fixation

EXCLUSION CRITERIA-

1. Age less than 18 years and those above 50 years.
2. Pre-existing lesions of hip such as osteonecrosis of femoral head and degenerative arthritis
3. Concomitant disease affecting hip joint.
4. Neurological disorder like seizures, psychosis or mental deterioration.
5. Femoral neck fractures with severe posterior comminution.
6. Open fractures
7. Bullet injuries.
8. Pathological fractures
9. Fracture neck of femur associated with dislocation of head
10. Acetabular fracture
11. Polytrauma

A routine preoperative clinical and radiological evaluation of the affected hip was carried out. Standardized antero-posterior (AP) and lateral radiograph of affected hip were performed preoperatively and postoperatively.

The data collected was recorded in a proforma and analysed using observational statistical analysis.

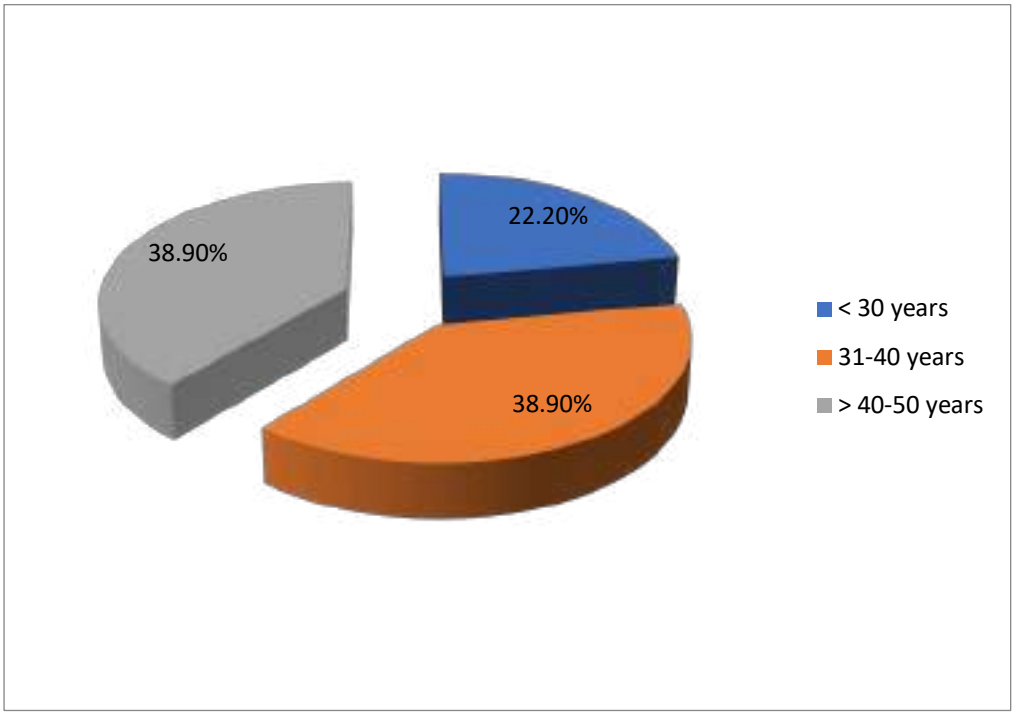
However, due to the COVID-19 pandemic the total number of cases achieved were lesser than expectation. COVID-19 pandemic affected both case recruitment and follow up.

OBSERVATION AND RESULTS

TABLE 1. AGE DISTRIBUTION

Age group	No. of cases	Percentage
< 30 yrs	4	22.2%
31-40 yrs	7	38.9%
> 40-50 yrs	7	38.9%
Total	18	100.0%

FIGURE 1. AGE DISTRIBUTION

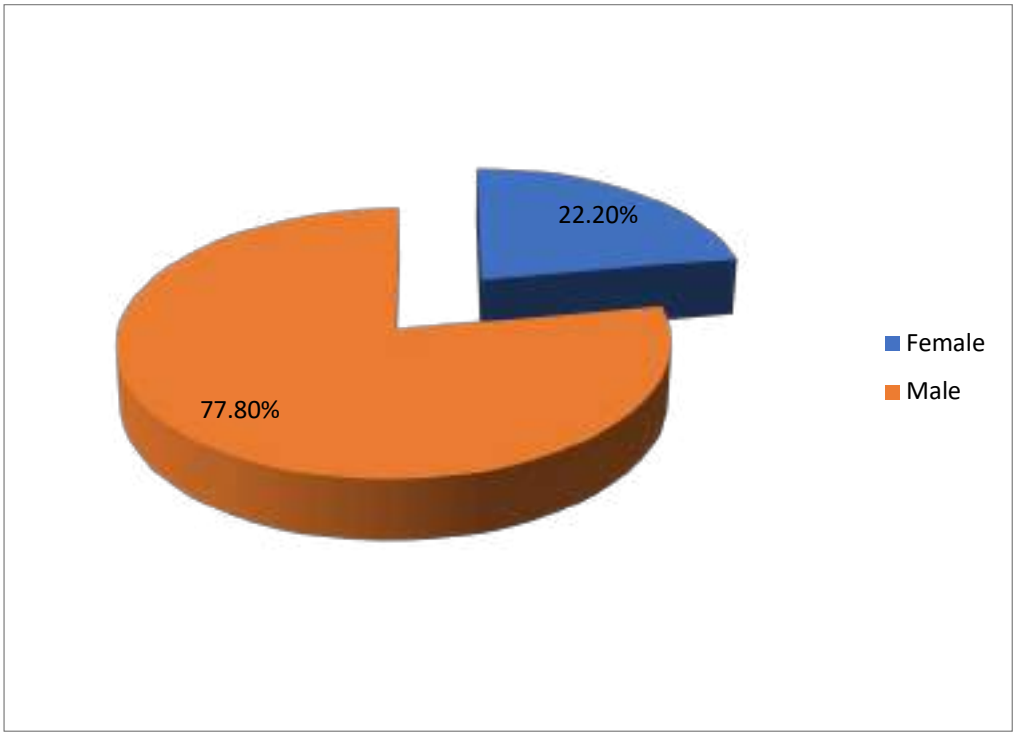


The above table and figure depict that out of 18 patients in this study, there were 4 (22.2%) patients in age group of less than 30 years, 7 (38.9%) patients in age group of 31-40 years, and 7 (38.9%) in age group of 41-50yrs.

TABLE 2. SEX DISTRIBUTION

Sex	No. of cases	Percentage
F	4	22.2%
M	14	77.8%
Total	18	100.0%

FIGURE 2. SEX DISTRIBUTION

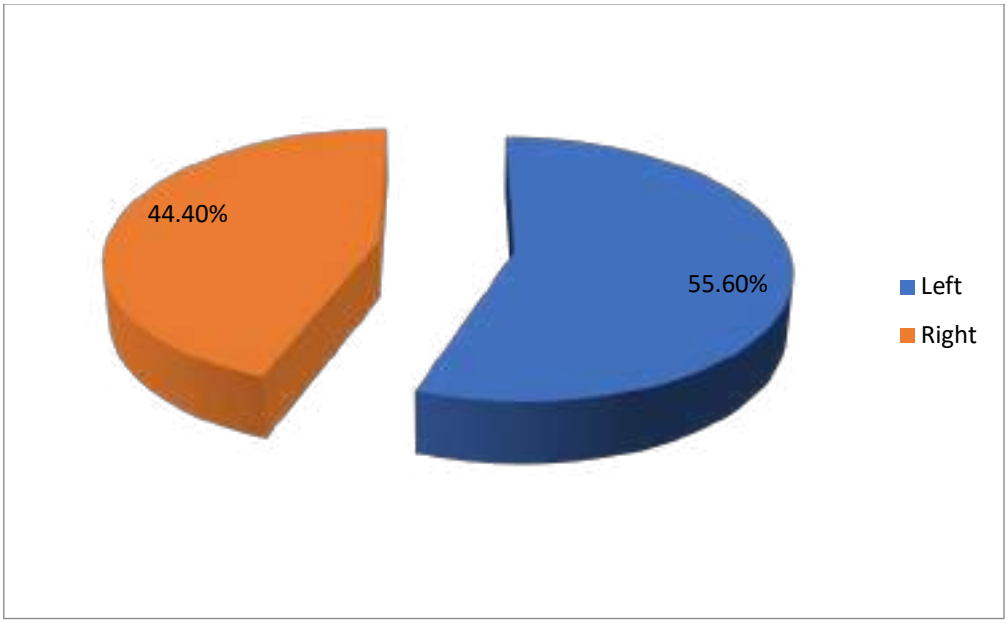


There were 14 (77.8%) male and 4 (22.2%) female patients.

TABLE 3. SIDE DISTRIBUTION

Side	No. of cases	Percentage
Left	10	55.6%
Right	8	44.4%
Total	18	100.0%

FIGURE 3. SIDE DISTRIBUTION

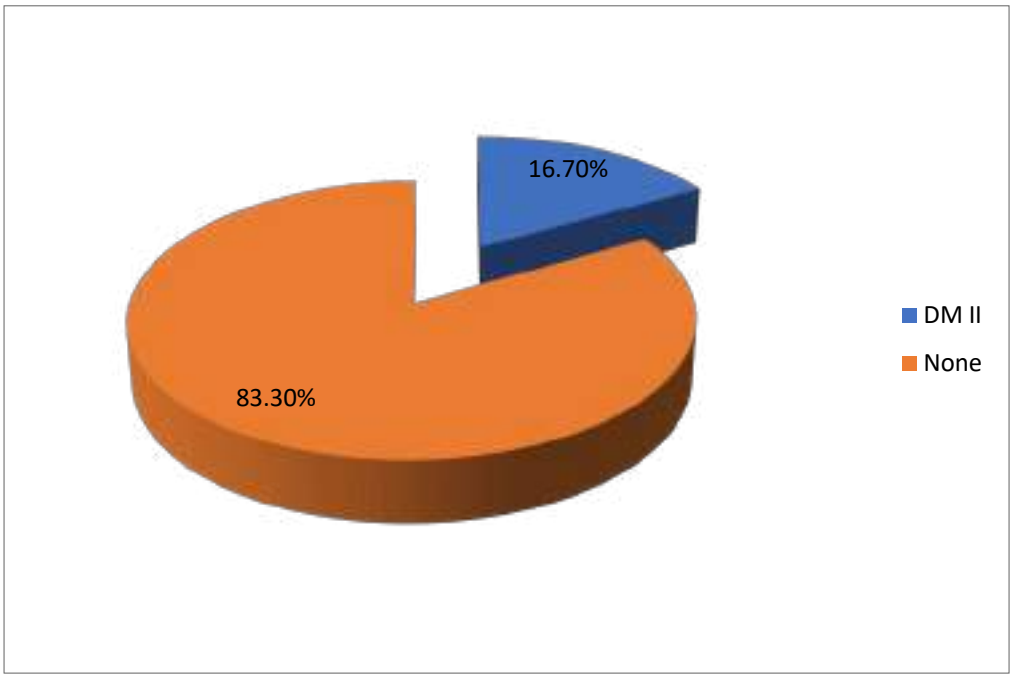


Out of total 18 patients, 10 (55.6%) patients had involvement of left side while 8 (44.4%) had involvement of right side.

TABLE 4. DISTRIBUTION OF ASSOCIATED COMORBIDITIES

Assoc comorbidities	No. of cases	Percentage
DM II	3	16.7%
Nil	15	83.3%
Total	18	100.0%

FIGURE 4. DISTRIBUTION OF ASSOCIATED COMORBIDITIES



Out of the total 18 patients, 3 (16.7%) patients were suffering from diabetes mellitus type 2. Rest 15 (83.3%) patients had no comorbidity.

TABLE 5. DISTRIBUTION OF PERSONAL HABITS

Alcoholic	No. of cases	Percentage
No	13	72.2%
Yes	5	27.8%
Total	18	100.0%
Smoker	No. of cases	Percentage
No	17	94.4%
Yes	1	5.6%
Total	18	100.0%

FIGURE 5 A. DISTRIBUTION OF PERSONAL HABITS (ALCOHOL)

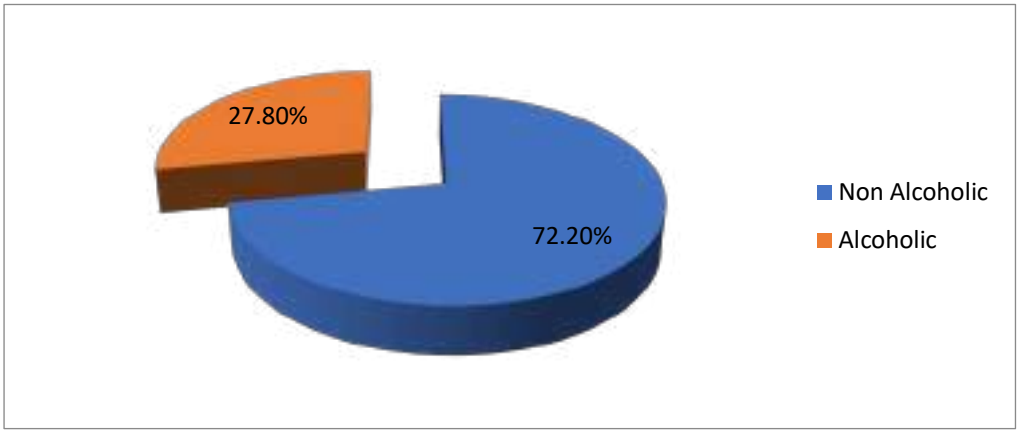
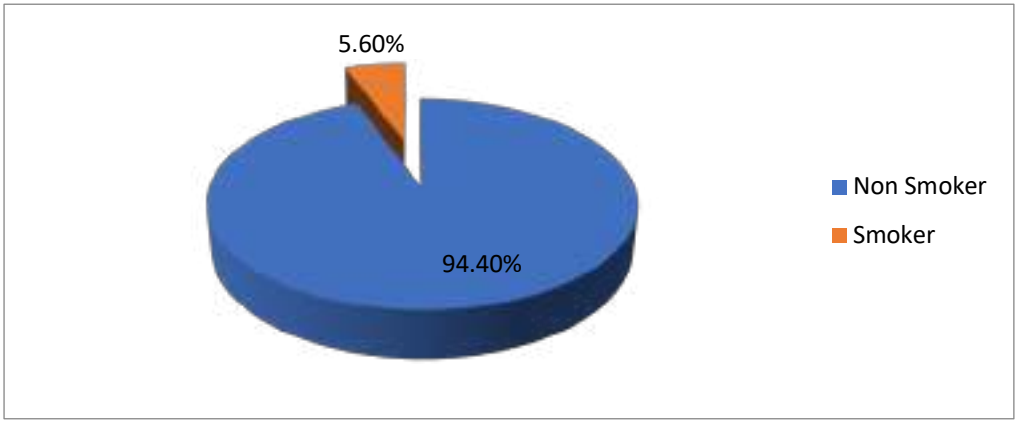


FIGURE 5 B. DISTRIBUTION OF PERSONAL HABITS (SMOKING)

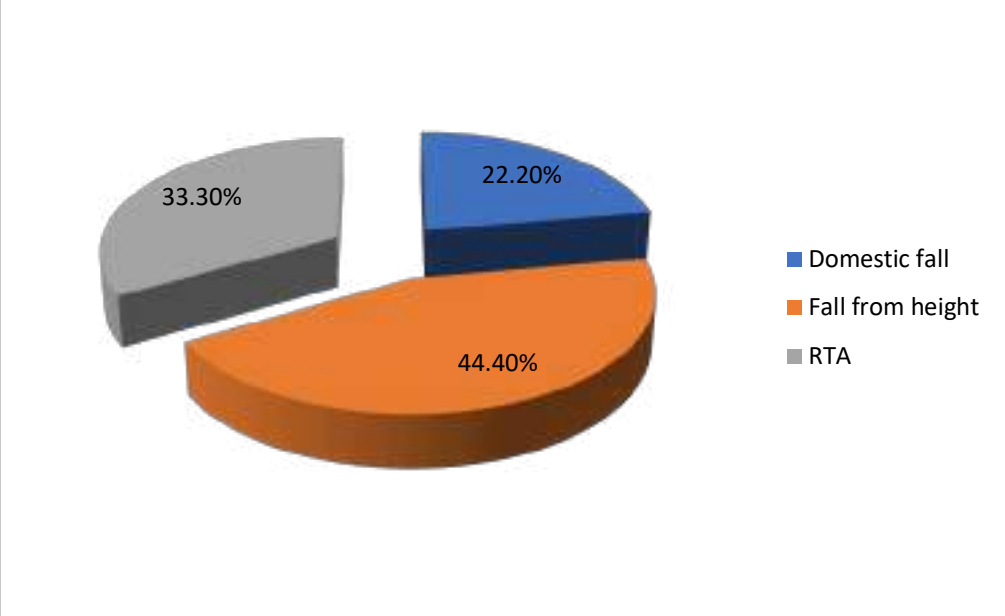


Out of 18 patients, 5 (27.8%) patients were alcoholic while only one (5.6%) was found to be smoker.

TABLE 6. MECHANISM OF INJURY

Mech of injury	No. of cases	Percentage
Domestic fall	4	22.2%
Fall from height	8	44.4%
RTA	6	33.3%
Total	18	100.0%

FIGURE 6. MECHANISM OF INJURY

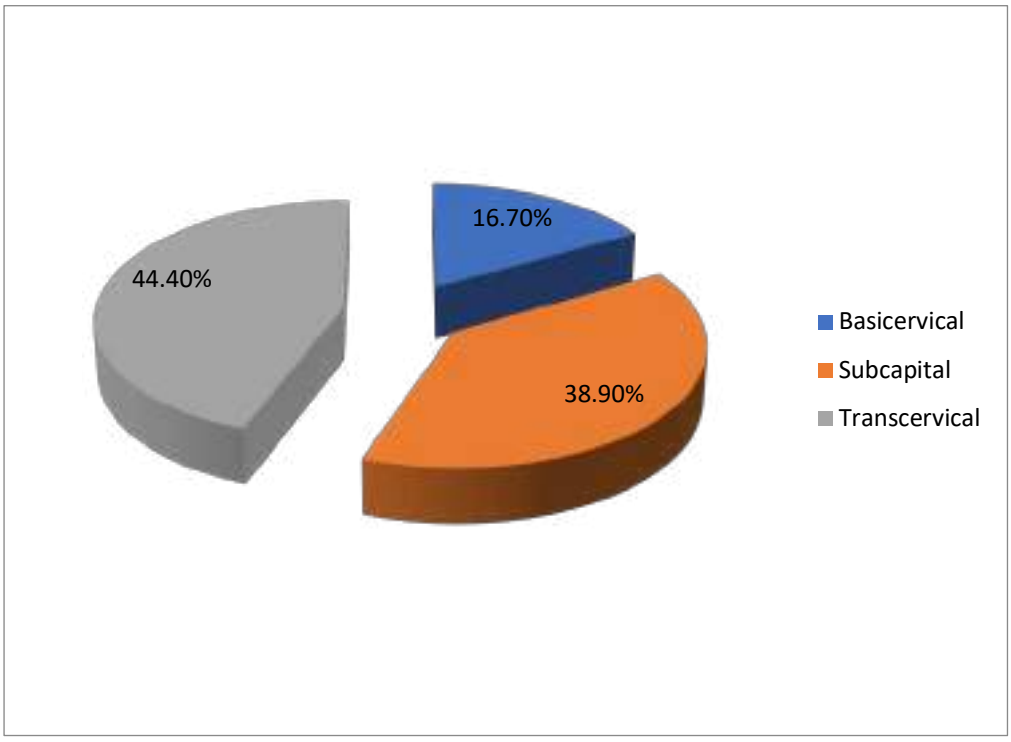


Out of total 18 patients the mechanism of injury was roadside accident in 6 (33.3%) patients, fall from height in 8 (44.4%) patients and domestic fall in 4 (22.2%) patients.

TABLE 7. LOCATION OF FRACTURE

Site of fracture	No. of cases	Percentage
Basicervical	3	16.7%
Subcapital	7	38.9%
Transcervical	8	44.4%
Total	18	100.0%

FIGURE 7. LOCATION OF FRACTURE

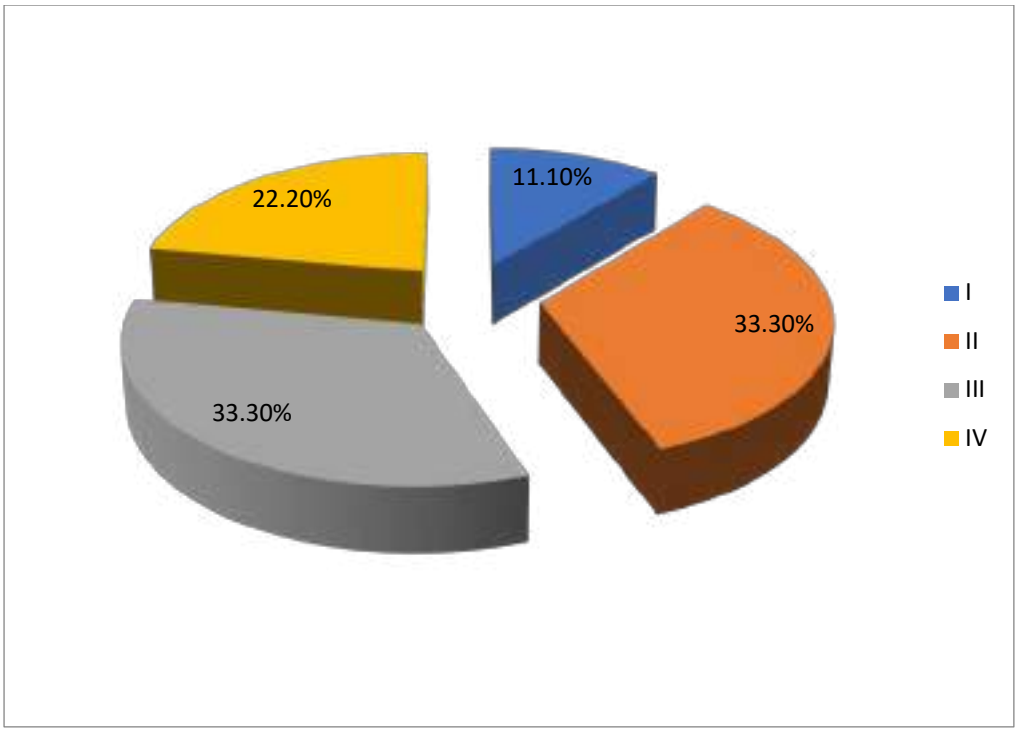


Location of fracture was either basal (3 patients), subcapital (7 patients) or transcervical (8 patients) i.e 16.7%, 38.9% or 44.4% respectively.

TABLE 8. CLASSIFICATION OF FRACTURE (GARDEN'S GRADE)

Garden type	No. of cases	Percentage
I	2	11.1%
II	6	33.3%
III	6	33.3%
IV	4	22.2%
Total	18	100.0%

FIGURE 8. CLASSIFICATION OF FRACTURE (GARDEN'S GRADE)

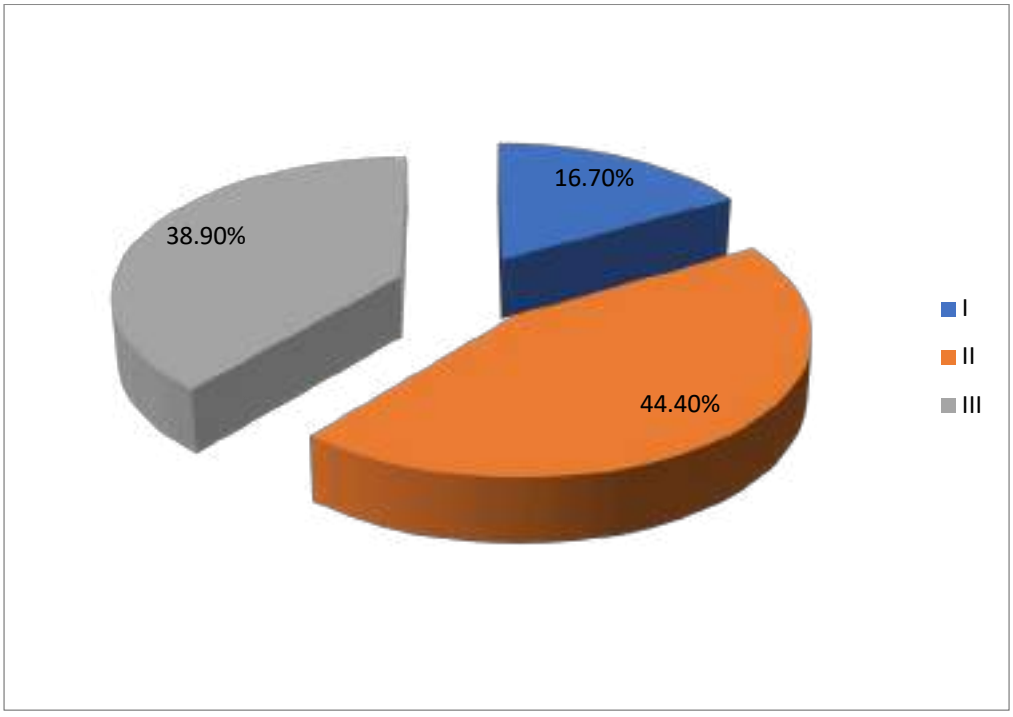


2 patients had Garden's grade fracture I, 6 patients had Garden's grade fracture II, 6 had Garden grade's fracture III and 4 patients had Garden's grade fracture IV.

TABLE 9. CLASSIFICATION OF FRACTURE (PAUWELS TYPE)

Pauwels type	No. of cases	Percentage
I	3	16.7%
II	8	44.4%
III	7	38.9%
Total	18	100.0%

FIGURE 9. CLASSIFICATION OF FRACTURE (PAUWELS TYPE)

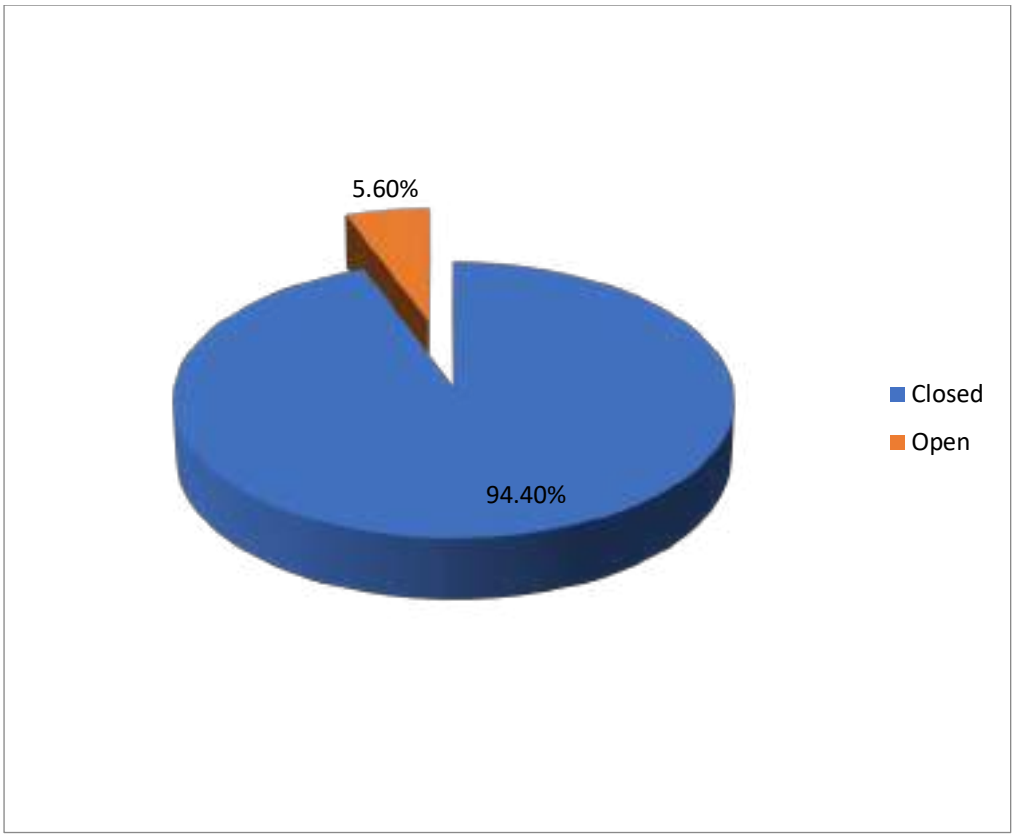


3 patients had Pauwels type fracture I, 8 patients had Pauwels type fracture II, and 7 had Pauwels type fracture III constituting 16.7%, 44.4% and 38.9% respectively under each subgroup.

TABLE 10. REDUCTION METHOD

Reduction Method	No. of cases	Percentage
Closed	17	94.4%
Open	1	5.6%
Total	18	100.0%

FIGURE 10. REDUCTION METHOD

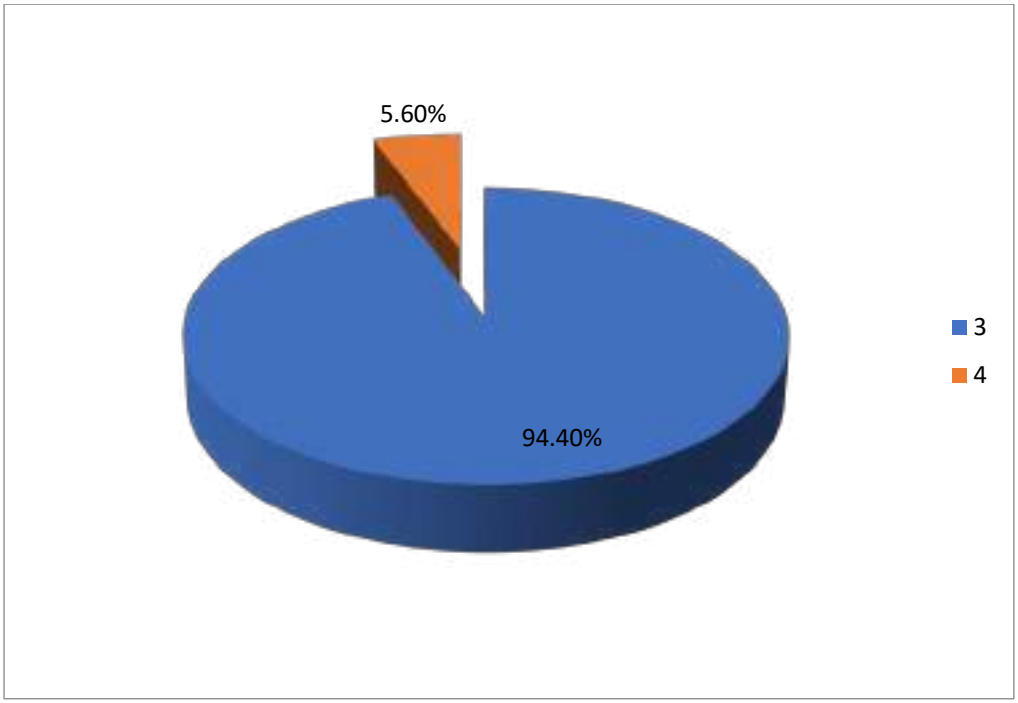


Only one patient (5.6%) underwent reduction by open method. Rest all underwent closed reduction.

TABLE 11. NUMBER OF SCREWS

No. of screws	No. of cases	Percentage
3	17	94.4%
4	1	5.6%
Total	18	100.0%

FIGURE 11. NUMBER OF SCREWS

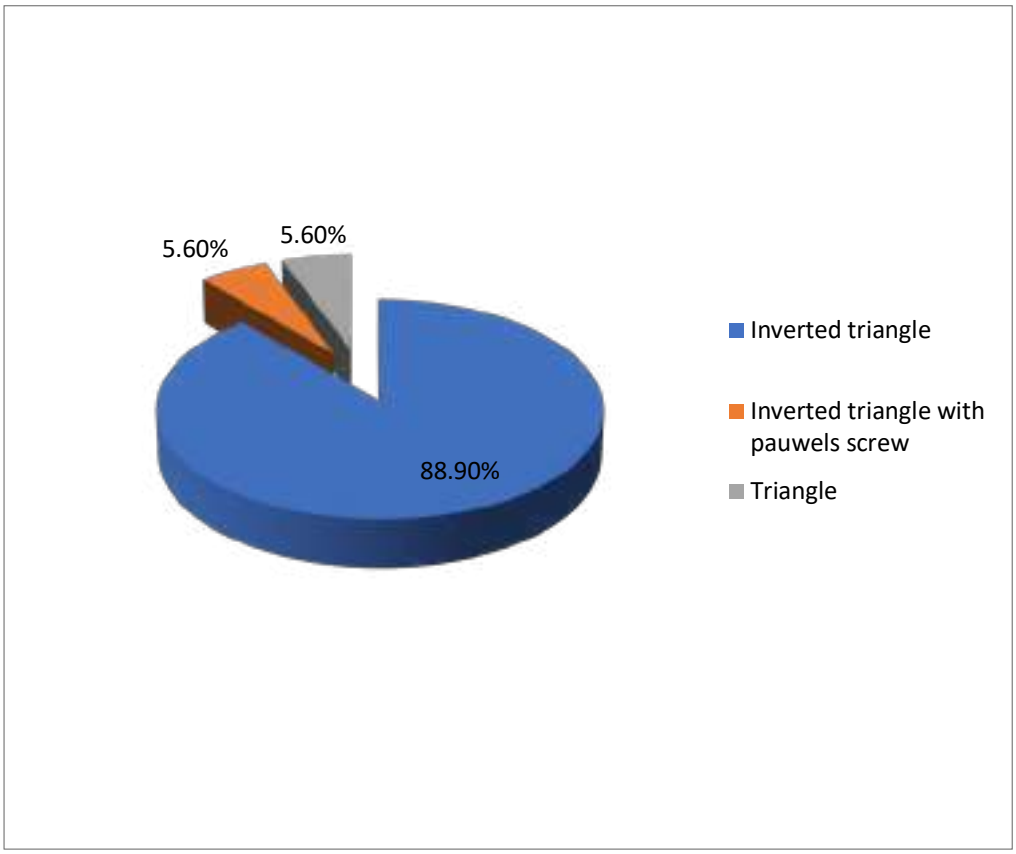


Only one patient (5.6%) underwent internal fixation using 4 cancellous cannulated screws (4th screw was Pauwels screw.), rest all fractures were fixed with 3 screws.

TABLE 12. ARRANGEMENT OF SCREWS

Arrangement of screws	No. of cases	Percentage
Inverted triangle	16	88.9%
Inverted triangle with Pauwels screw	1	5.6%
Triangle	1	5.6%
Total	18	100.0%

FIGURE 12. ARRANGEMENT OF SCREWS

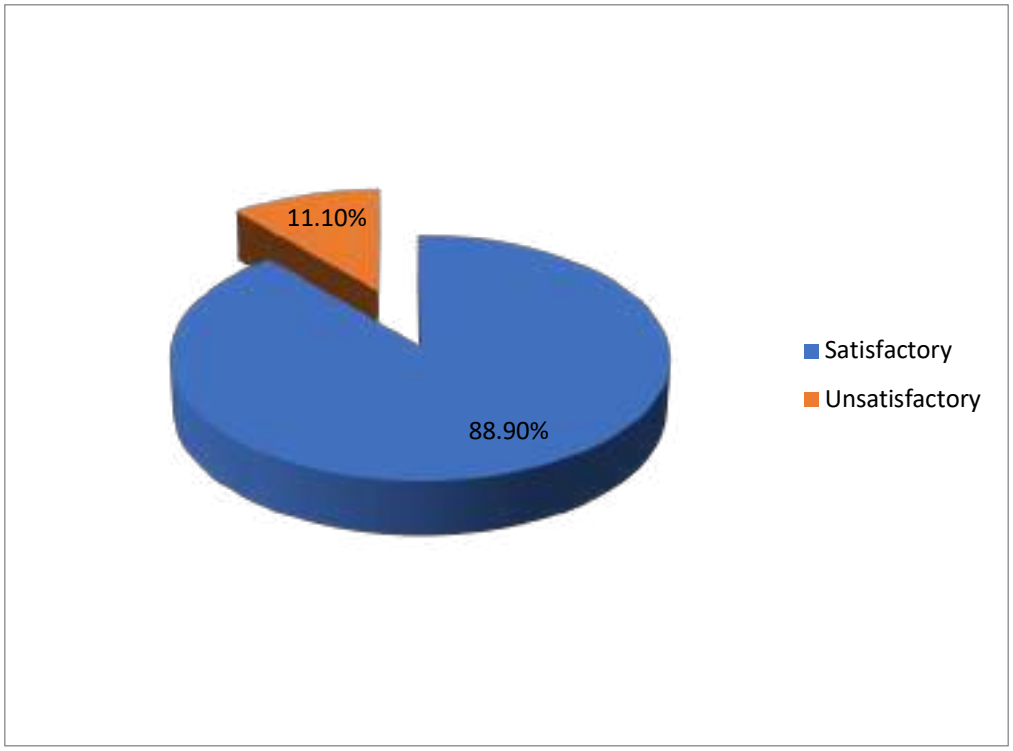


All of the fractures were fixed with inverted triangle arrangements of screw except for two fracture one of which was fixed in triangular arrangement and the other was fixed in inverted triangle arrangement with one Pauwels screw.

TABLE 13. REDUCTION ADEQUACY (REVERSE S SIGN)

Reduction (Reverse S sign)	No. of cases	Percentage
Satisfactory	16	88.9%
Unsatisfactory	2	11.1%
Total	18	100.0%

FIGURE 13. REDUCTION ADEQUACY (REVERSE S SIGN)

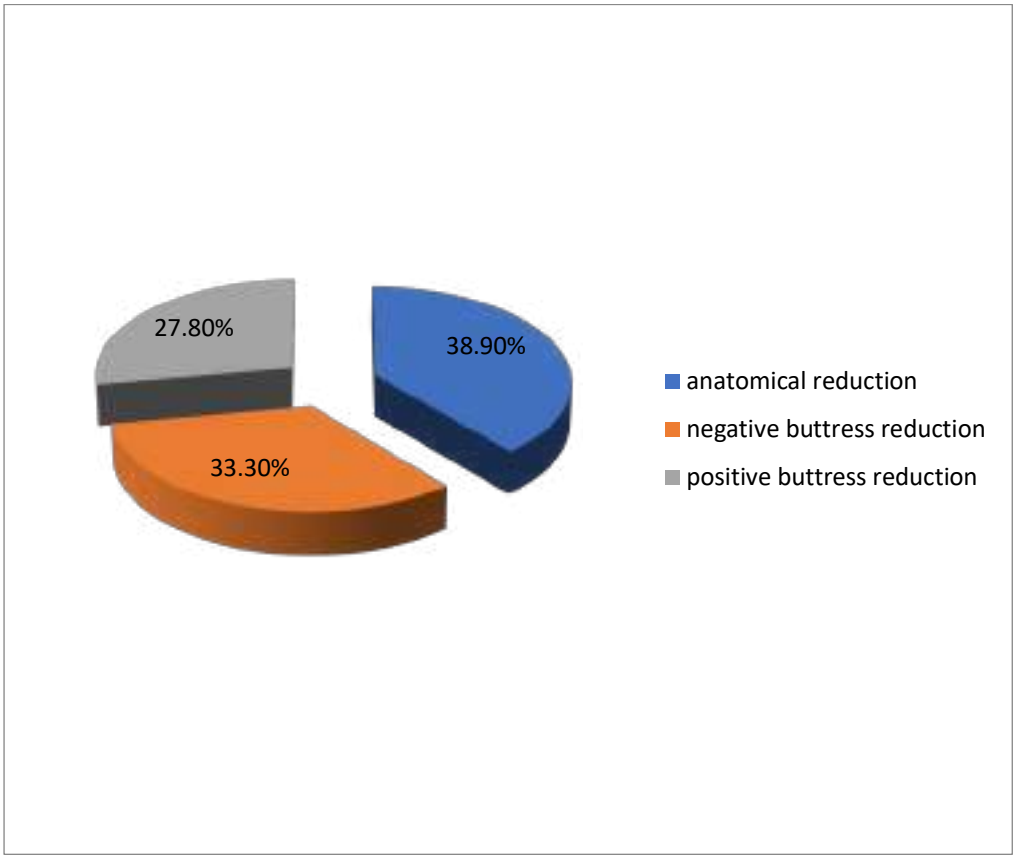


The fracture reduction was assessed based on multiple parameters from post operative X-rays in antero-posterior and lateral views. The fracture reduction was satisfactory in 16 patients (88.9%) whereas in 2 patient (11.1%), the reduction was unsatisfactory on the basis of reverse s sign (proposed by Lowell).[106]

TABLE 14. TYPE OF REDUCTION

Type Of Reduction	No. of cases	Percentage
anatomical reduction	7	38.9%
negative buttress reduction	6	33.3%
positive buttress reduction	5	27.8%
Total	18	100.0%

FIGURE 14. TYPE OF REDUCTION



The fracture reduction was also assessed from post operative radiographs in antero-posterior and lateral views on the basis of type of reduction as proposed by Gotfried et al in 2013.[29] Out of total 18 patients 7 (38.9%) patients had anatomical reduction, 5 (27.8%) patients had positive buttress reduction and 6 (33.3%) patients had negative buttress reduction.

TABLE 15A. REDUCTION ADEQUACY (GARDEN ALIGNMENT INDEX, AP VIEW)

	N	Minimum	Maximum	Mean	SD
Garden alignment index AP view	18	160.00	177.00	167.33	4.07

TABLE 15B. REDUCTION ADEQUACY (GARDEN ALIGNMENT INDEX, LATERAL VIEW)

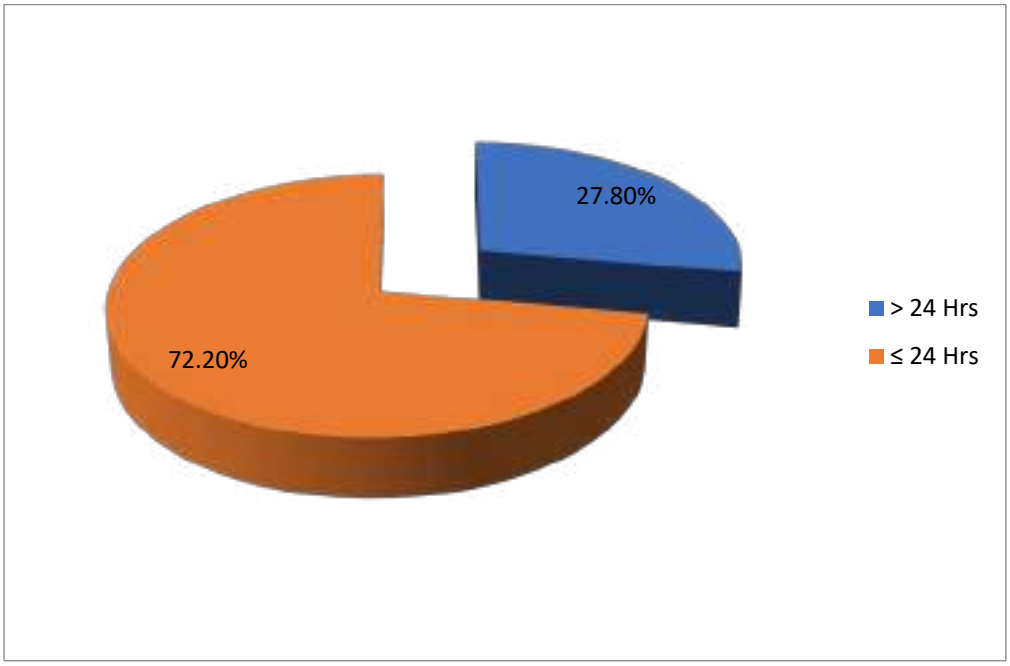
	N	Minimum	Maximum	Mean	SD
Garden alignment index Lat. view	18	156.00	185.00	170.28	6.88

The fracture reduction was further assessed from post operative X rays in antero-posterior and lateral views based on garden alignment index. Normal range for garden alignment index was taken as 160-180 degree on and ap and lateral view of post operative X rays. All patients had garden alignment index as within normal range on anteroposterior view while 2 (11.1%) patients had garden alignment index outside normal range on lateral radiograph. Average garden alignment index on AP view was found to be 167.33 degree with standard deviation of 4.07 degree while on lateral view same was found to be 170.28 degree with standard deviation of 6.88 degree.

TABLE 16. TIME TO SURGERY

Time to surgery< 24hrs	No. of cases	Percentage
No	5	27.8%
Yes	13	72.2%
Total	18	100.0%

FIGURE 15. TIME TO SURGERY

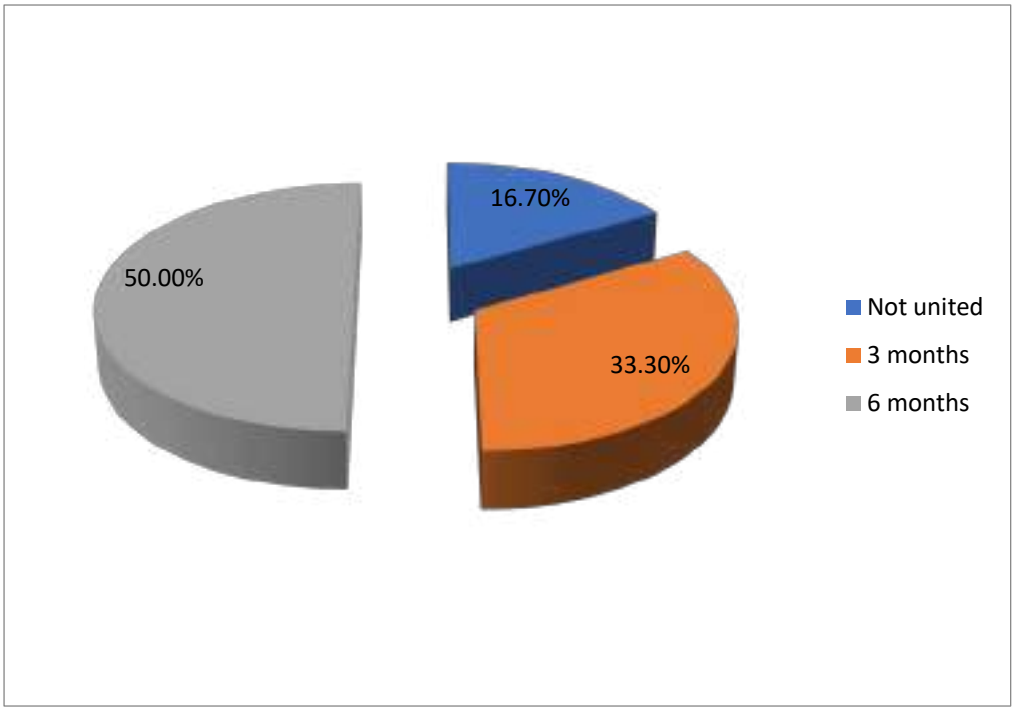


Based on the time of surgery, two groups were formed 1st group included patients who were operated in less than 24 hours of the fracture which included 13 (72.2%) patients and second group which included 5 (27.8%) patients who were operated more than 24 hours of the fracture.

TABLE 17. TIME TO UNION

Time to union	No. of cases	Percentage
Not united	3	16.7%
3 months	6	33.3%
6 months	9	50.0%
Total	18	100.0%

FIGURE 16. TIME TO UNION

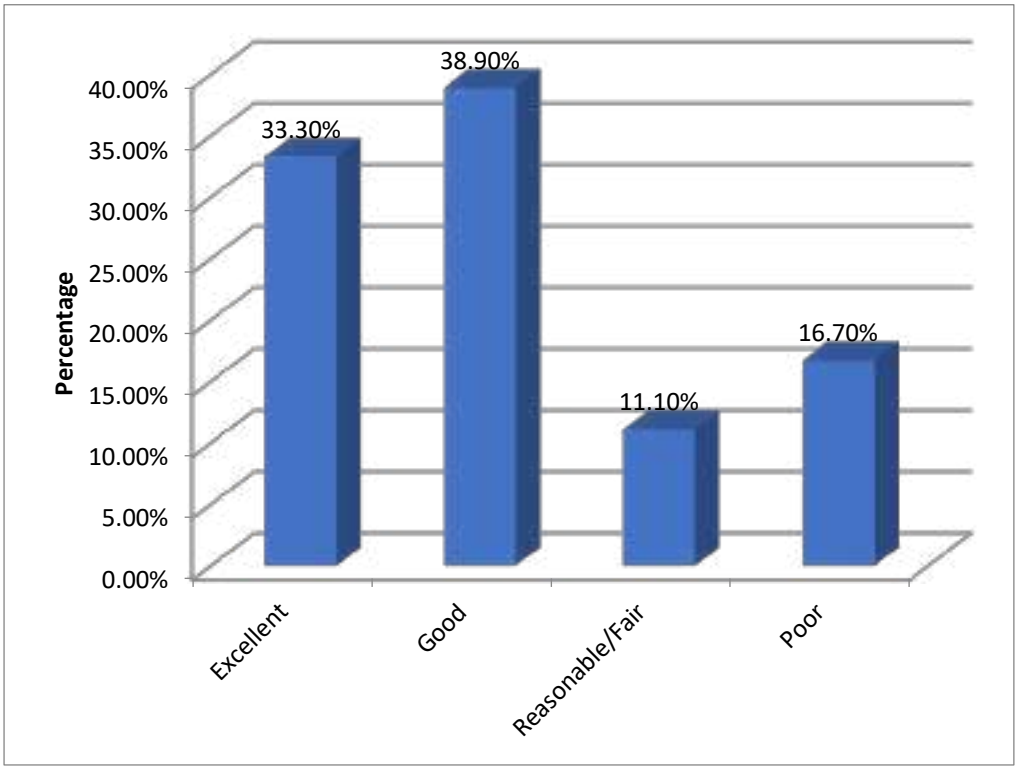


Out of the total 18 patients recruited, 6 (33.3%) patients had radiological union in around 3 months while 9 (50%) patients had union time of around 6 months. However, 3 (16.7%) did not have radiological union at all.

TABLE 18. FUNCTIONAL OUTCOME (BASED ON MODIFIED HARRIS HIP SCORE)

Functional Outcome	No. of cases	Percentage
Excellent	6	33.3%
Good	7	38.9%
Reasonable	2	11.1%
Poor	3	16.7%
Total	18	100.0%

FIGURE 17. FUNCTIONAL OUTCOME (BASED ON MODIFIED HARRIS HIP SCORE)

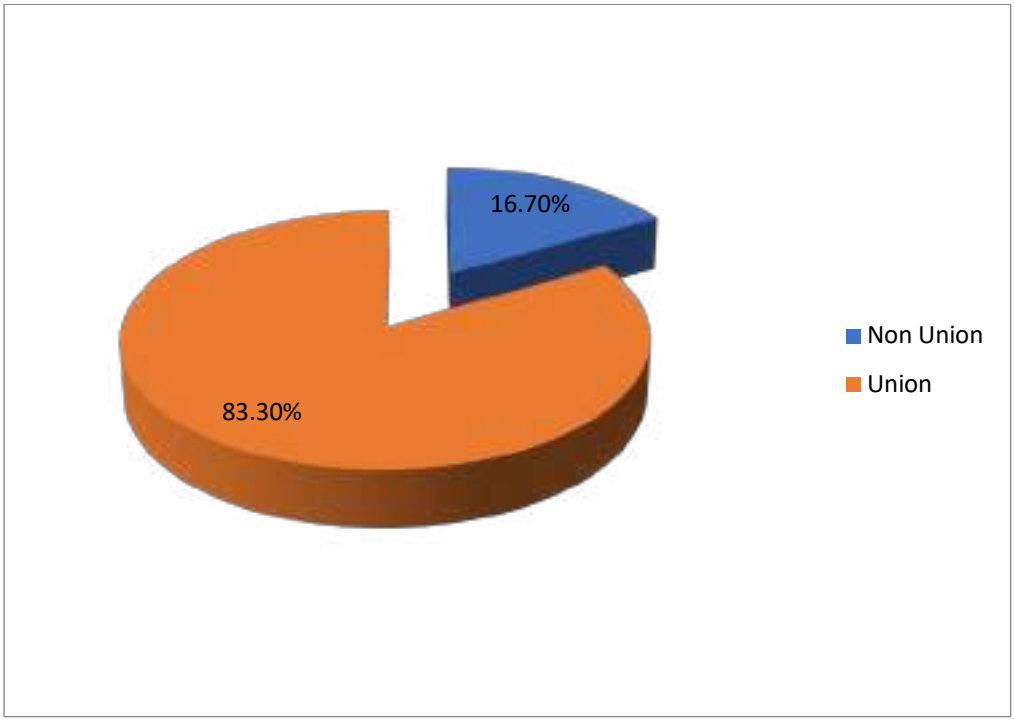


The functional outcome was observed to be excellent in 6 (33.3%) patients, good in 7 (38.9%), reasonable in 2 (11.1%) and poor in 3 (16.7%) patients based on modified Harris hip score. It was observed that that 72.2% of patients achieved upto good functional outcome.

TABLE 19. RADIOLOGICAL OUTCOME

Radiological Outcome	No. of cases	Percentage
Non-Union	3	16.7%
Union	15	83.3%
Total	18	100.0%

FIGURE 18. RADIOLOGICAL OUTCOME

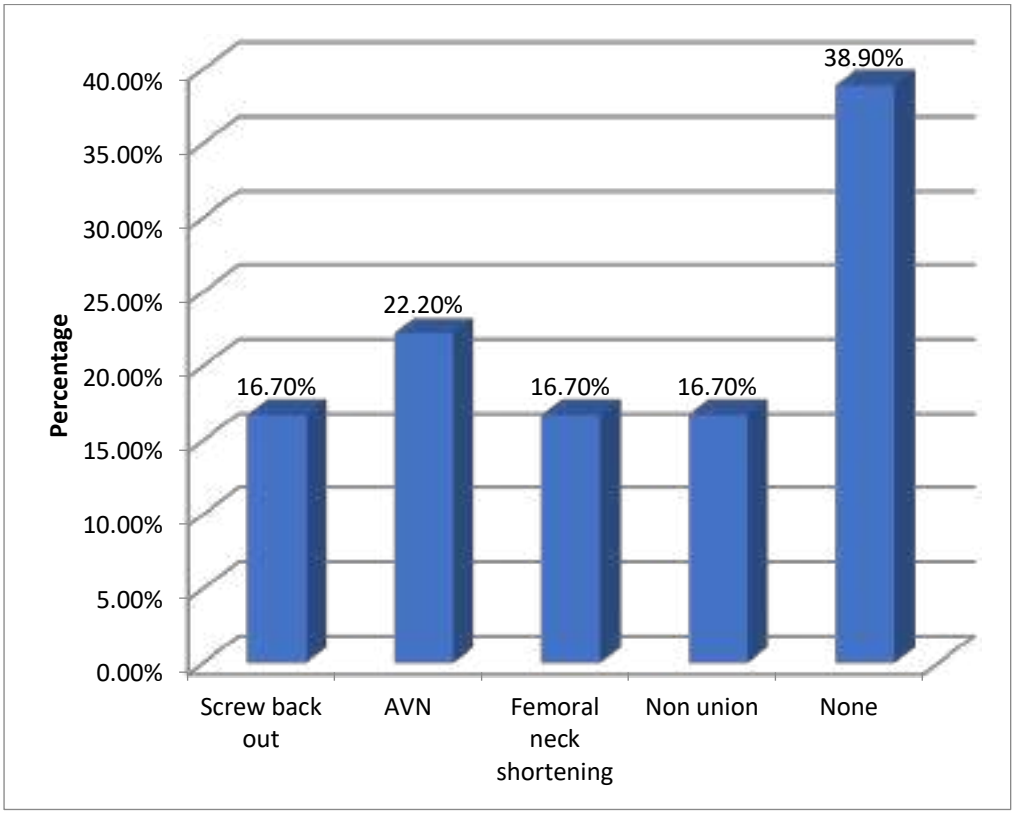


There was radiological union in 15 (83.3%) patients seen as obliteration of fracture line and trabecular realignment on radiographs and non-union in 3 (16.7%).

TABLE 20. COMPLICATIONS

Complications	No. of cases	Percentage
Screw Back Out	3	16.7%
AVN	4	22.2%
Femoral neck shortening	3	16.7%
Non-union	3	16.7%
None	7	38.9%

FIGURE 19. COMPLICATIONS

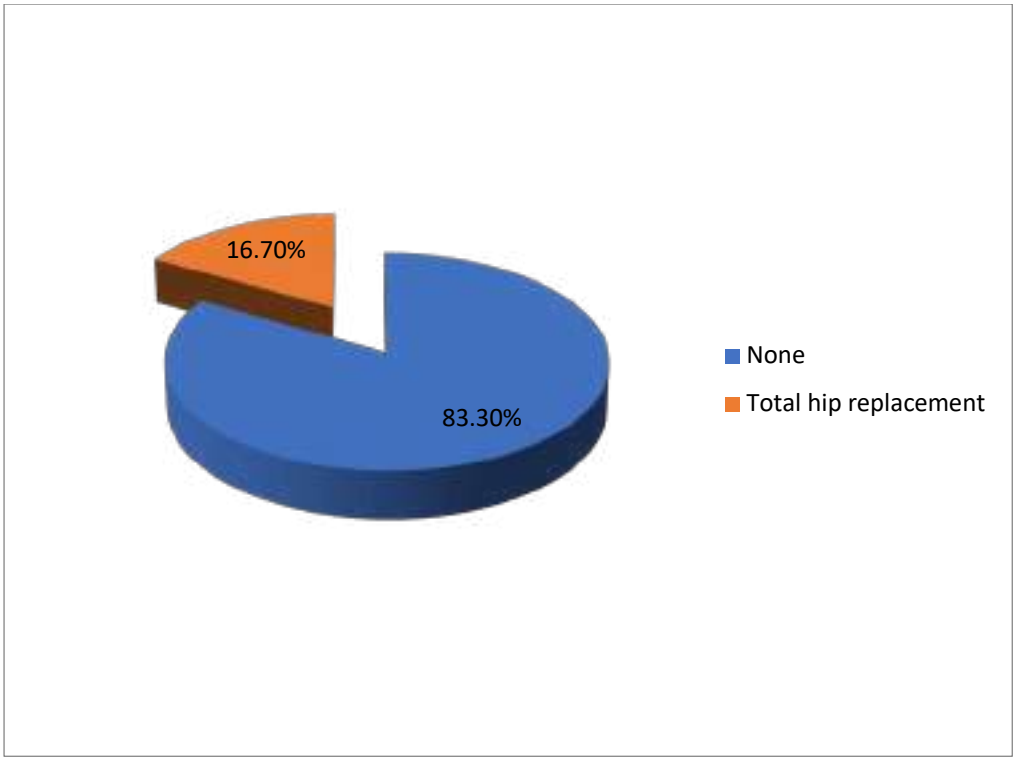


Patients were followed up for long term complications. Avascular necrosis of femoral head was found in 4 (22.2%) patients. Screw back out was seen on follow up in 3 (16.7%) patients. Non-union was seen in 3 (16.7%) patients. Femoral neck shortening which was found by digitally superimposing affected hip post union with non-affected side was found to be in 3 (16.7%) patients.

TABLE 21. SECONDARY PROCEDURE

Secondary Procedure	No. of cases	Percentage
None	15	83.3%
Total hip replacement	3	16.7%
Total	18	100.0%

FIGURE 20. SECONDARY PROCEDURE

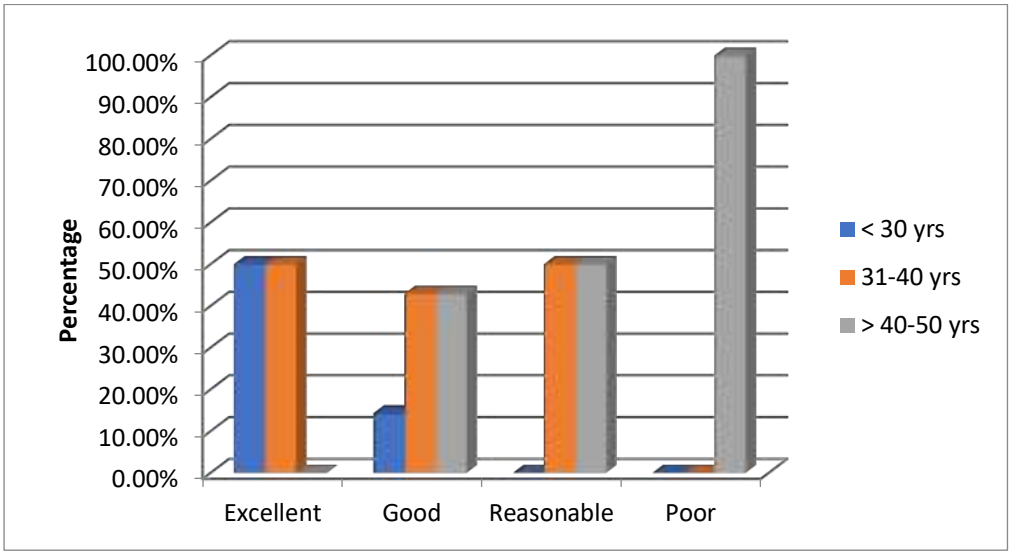


Out of the 18 patients, only three patients (16.7%) underwent secondary procedure. All three of them underwent total hip replacement.

TABLE 22. CORRELATION OF AGE AT THE TIME OF FRACTURE WITH FUNCTIONAL OUTCOME

		Functional Outcome								Total
		Excellent		Good		Reasonable		Poor		
Age group	< 30	3	50.0%	1	14.3%	0	0.0%	0	0.0%	4
	31-40	3	50.0%	3	42.9%	1	50.0%	0	0.0%	7
	> 40-50	0	0.0%	3	42.9%	1	50.0%	3	100.0%	7
Total		6	100.0%	7	100.0%	2	100.0%	3	100.0%	18

FIGURE 21. CORRELATION OF AGE AT THE TIME OF FRACTURE WITH FUNCTIONAL OUTCOME

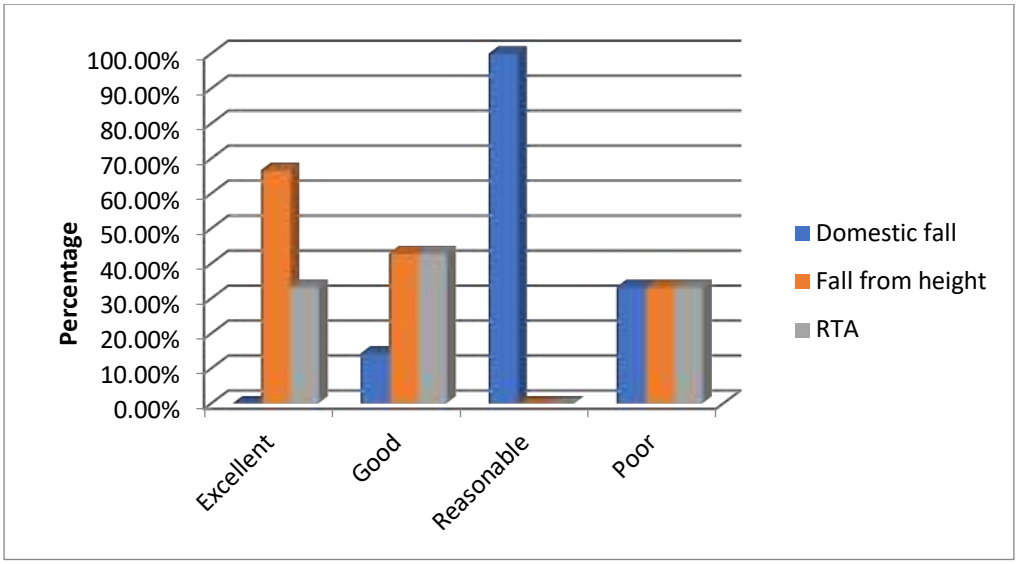


Out of 6 patients with excellent outcomes, 3 (50%) patients were in age group of less than 30yrs, 3 (50%) were in age group 31-40 and none in the age group 41-50 years. Out of 7 patients with good outcome, 1 (14.3%) were less than 30 years of age, 3 (42.9%) were in age group of 31-40 years and 3 (42.9%) were in age group of 41-50 years. Also, out of the total number of patients with reasonable outcome, 50% were within 31-40 years of age and 50% were from age group 41-50 years. Out of the total number of patients with poor outcome ,100% were from age group 41-50 years. This difference was found to be significant. Hence, the study shows that younger age groups have better functional outcome.

TABLE 23. CORRELATION OF MECHANISM OF INJURY WITH FUNCTIONAL OUTCOME

		Functional Outcome								Total
		Excellent		Good		Reasonable		Poor		
Mech of injury	Domestic fall	0	0.0%	1	14.3%	2	100.0%	1	33.3%	4
	Fall from height	4	66.7%	3	42.9%	0	0.0%	1	33.3%	8
	RTA	2	33.3%	3	42.9%	0	0.0%	1	33.3%	6
Total		6	100.0%	7	100.0%	2	100.0%	3	100.0%	18

FIGURE 22. CORRELATION OF MECHANISM OF INJURY WITH FUNCTIONAL OUTCOME

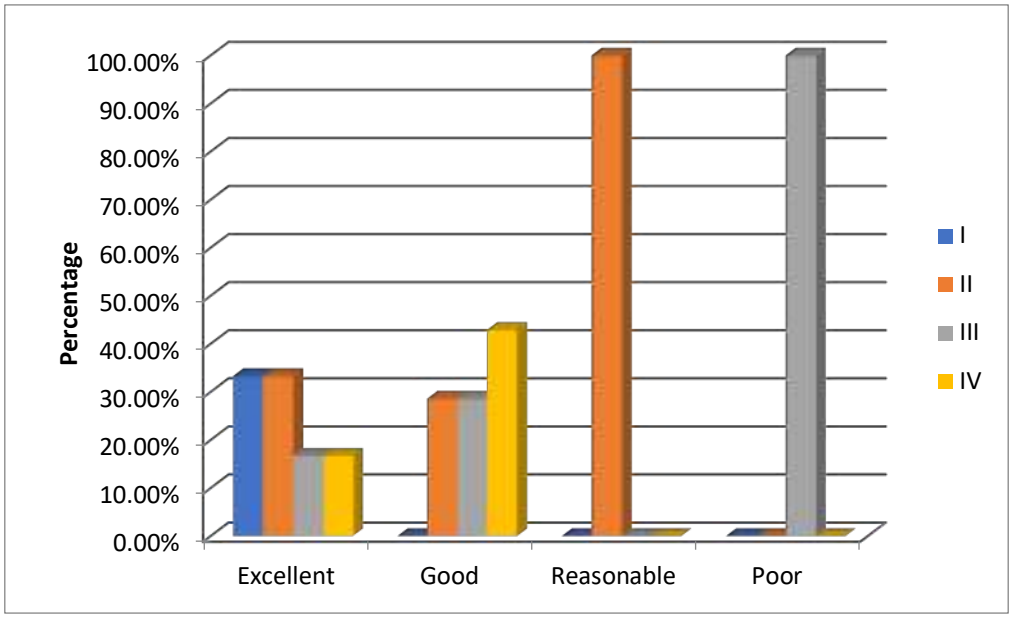


This study shows that 6 patients in whom functional outcome was excellent, mechanism of injury was roadside accident in 2 (33.3%) and fall from height in 4 (66.7%). Out of 7 patients in whom functional outcome was good, 3 (42.9%) patients had roadside accident. Out 2 patients in whom functional outcome was reasonable, 2 (100%) had domestic fall. This difference was probably age related with all of domestic fall were aged more than 40 years with all of them attaining preinjury level of activity with difficulty.

TABLE 24. CORRELATION OF FRACTURE DISPLACEMENT WITH FUNCTIONAL OUTCOME

		Functional Outcome								Total
		Excellent		Good		Reasonable		Poor		
Garden type	I	2	33.3%	0	0.0%	0	0.0%	0	0.0%	2
	II	2	33.3%	2	28.6%	2	100.0%	0	0.0%	6
	III	1	16.7%	2	28.6%	0	0.0%	3	100.0%	6
	IV	1	16.7%	3	42.9%	0	0.0%	0	0.0%	4
Total		6	100.0%	7	100.0%	2	100.0%	3	100.0%	18

FIGURE 23. CORRELATION OF FRACTURE DISPLACEMENT WITH FUNCTIONAL OUTCOME

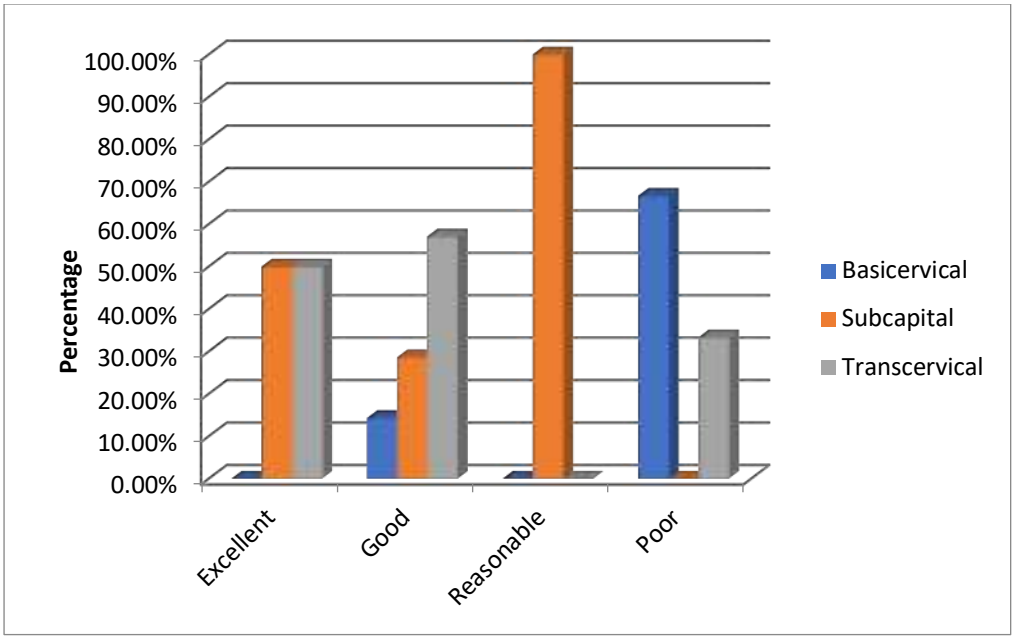


Out of the total 10 displaced fractures belonging to Garden grade III and IV, 3 (30%) had poor functional outcome while out of the total 8 undisplaced fracture belonging to Garden grade I and II, 6 (75%) had upto good functional outcome. This shows association of fracture displacement with increased chances of poor functional outcome.

TABLE 25. CORRELATION OF LOCATION OF FRACTURE WITH FUNCTIONAL OUTCOME

		Functional Outcome								Total
		Excellent		Good		Reasonable		Poor		
Site of fracture	Basicervical	0	0.0%	1	14.3%	0	0.0%	2	66.7%	3
	Subcapital	3	50.0%	2	28.6%	2	100.0%	0	0.0%	7
	Transcervical	3	50.0%	4	57.1%	0	0.0%	1	33.3%	8
Total		6	100.0%	7	100.0%	2	100.0%	3	100.0%	18

FIGURE 24. CORRELATION OF LOCATION OF FRACTURE WITH FUNCTIONAL OUTCOME

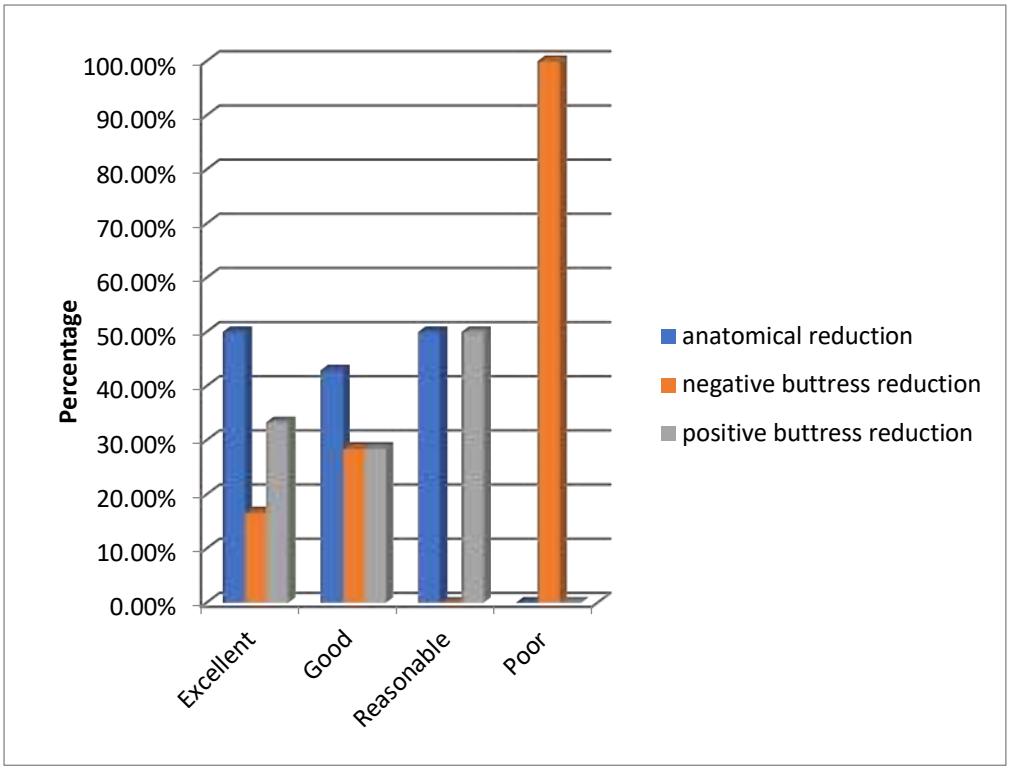


Out of 6 patients with excellent functional outcome, 3 (50%) patients had subcapital fracture and 3 (50%) had transcervical fracture. Out of 7 patients with good functional outcome, 1 (14.3%) patient had basal fracture, 2 (28.6%) had subcapital fracture and 4 (57.1%) had transcervical fracture. Out of total 2 patients with reasonable functional outcome, the incidence of subcapital was 2 (100%). Out of 3 patients with poor functional outcome, 2 (66.7%) patients had basal fracture and 1 (33.3%) had transcervical fracture. Since there were fewer number of patients of amongst each subgroup, this correlation between location of fracture and functional outcome was not significant.

TABLE 26. CORRELATION OF TYPE OF REDUCTION WITH FUNCTIONAL OUTCOME

		Functional Outcome								Total
		Excellent		Good		Reasonable		Poor		
Type Of Reduction	anatomical reduction	3	50.0%	3	42.9%	1	50.0%	0	0.0%	7
	negative buttress reduction	1	16.7%	2	28.6%	0	0.0%	3	100.0%	6
	positive buttress reduction	2	33.3%	2	28.6%	1	50.0%	0	0.0%	5
Total		6	100.0%	7	100.0%	2	100.0%	3	100.0%	18

FIGURE 25. CORRELATION OF TYPE OF REDUCTION WITH FUNCTIONAL OUTCOME



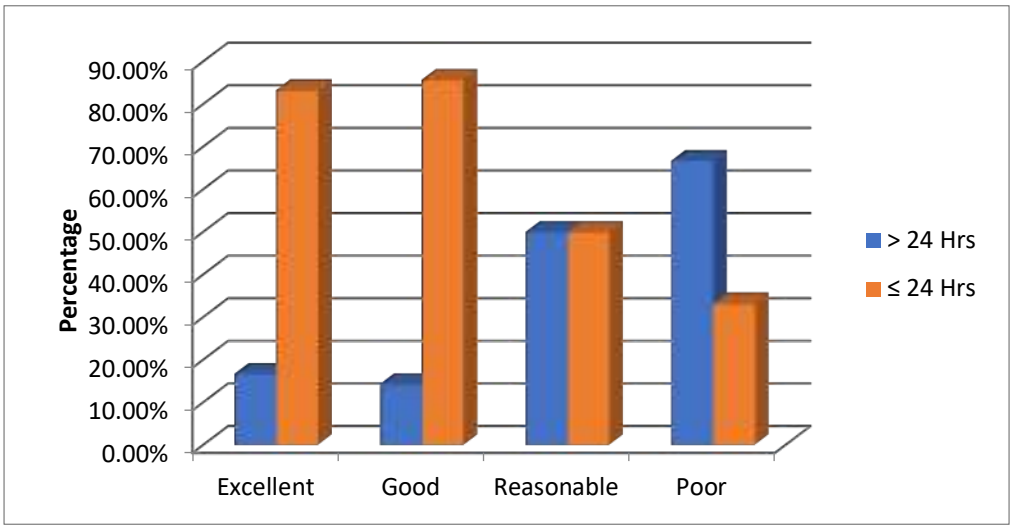
Out of total 6 patients with excellent outcome, 3 (50%) had anatomical reduction, 2 (33.3%) patients had positive buttress reduction and only one (16.7%) patient had negative buttress reduction. Amongst patient

with good outcome 3 (42.9%) had anatomical reduction, 2 (28.6%) had positive buttress reduction and only 2 (28.6%) had negative buttress reduction. Out of the total 3 patients with poor outcome all three (100%) had negative buttress reduction. Out of the total 6 patients with negative buttress reduction, 3 (50%) patients had poor functional outcome indicating towards association of poor functional outcome with negative buttress reduction, as described by Gotfried et al. in their study.[29]

TABLE 27. CORRELATION OF TIME TO SURGERY WITH FUNCTIONAL OUTCOME

		Functional Outcome								Total
		Excellent		Good		Reasonable		Poor		
Time to surgery less than 24hrs	No	1	16.7%	1	14.3%	1	50.0%	2	66.7%	5
	Yes	5	83.3%	6	85.7%	1	50.0%	1	33.3%	13
Total		6	100.0%	7	100.0%	2	100.0%	3	100.0%	18

FIGURE 26. CORRELATION OF TIME TO SURGERY WITH FUNCTIONAL OUTCOME

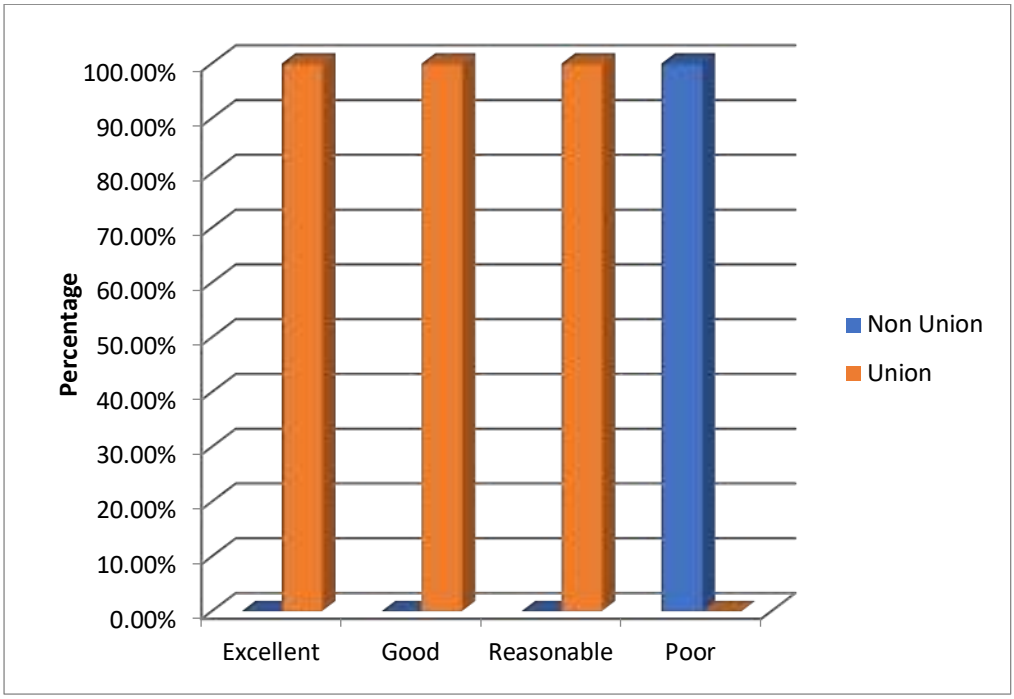


Among 13 patients operated within 24 hours of injury, 5 had excellent, 6 good, 2 reasonable and 1 had poor functional outcome. There were 5 were operated after 24 hours of injury, delay being caused possibly because of their medical conditions, out of which 1 had excellent, 1 good, 1 had reasonable and 2 had poor outcome. Delay in surgery for more than 24 hours was mostly (66.6%) associated with reasonable or poor outcome.

TABLE 28. CORRELATION OF RADIOLOGICAL OUTCOME WITH FUNCTIONAL OUTCOME

		Functional Outcome								Total
		Excellent		Good		Reasonable		Poor		
Radiological Outcome	Non-Union	0	0.0%	0	0.0%	0	0.0%	3	100.0%	3
	Union	6	100.0%	7	100.0%	2	100.0%	0	0.0%	15
Total		6	100.0%	7	100.0%	2	100.0%	3	100.0%	18

FIGURE 27. CORRELATION OF RADIOLOGICAL OUTCOME WITH FUNCTIONAL OUTCOME

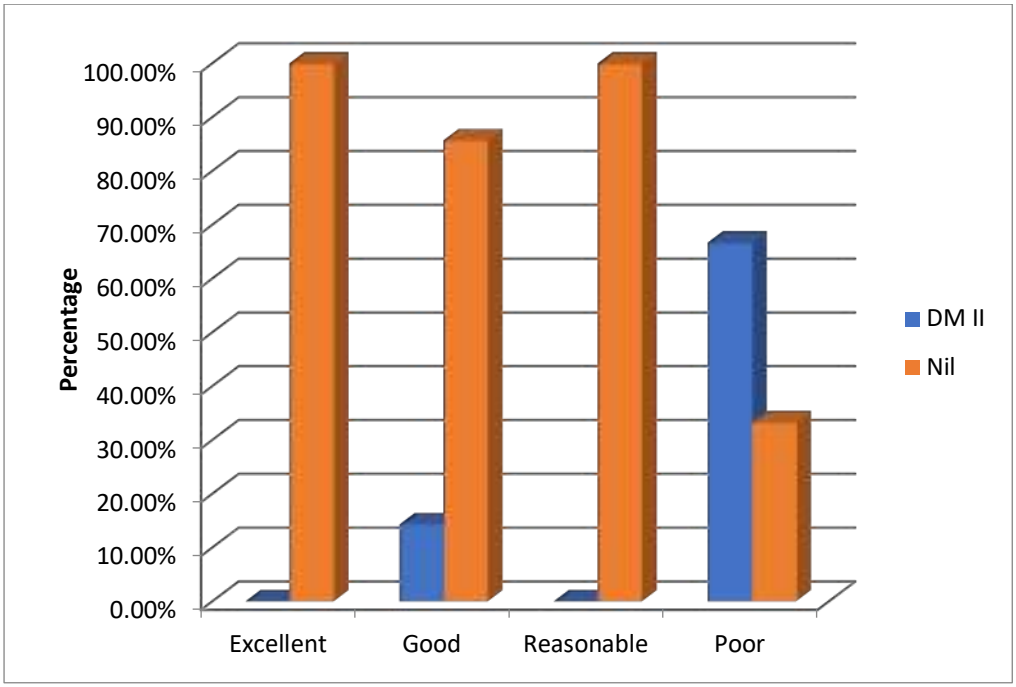


Amongst total 18 patients, 15 patients had radiological union while 3 had non-union at fracture site radiologically. All the patients with radiological non-union had poor functional outcome reiterating disability caused due to non-union amongst these patients.

TABLE 29. CORRELATION OF ASSOCIATED COMORBIDITIES WITH FUNCTIONAL OUTCOME

		Functional Outcome								Total
		Excellent		Good		Reasonable		Poor		
Assoc comorbidities	DM II	0	0.0%	1	14.3%	0	0.0%	2	66.7%	3
	Nil	6	100.0%	6	85.7%	2	100.0%	1	33.3%	15
Total		6	100.0%	7	100.0%	2	100.0%	3	100.0%	18

FIGURE 28. CORRELATION OF ASSOCIATED COMORBIDITIES WITH FUNCTIONAL OUTCOME

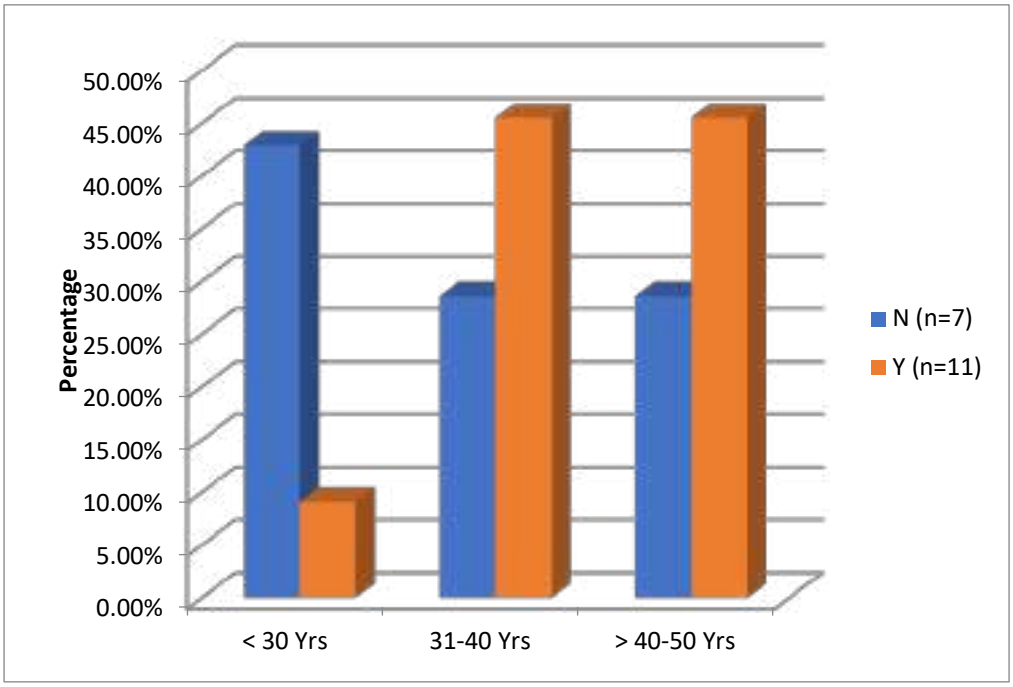


The above-mentioned table shows that the associated diabetes mellitus did affect the functional outcome of the patient. This may be attributed to the fact that patients with this comorbidity already had a compromised physiological capability of healing of the fracture and functional compromise in preinjury state.

TABLE 30. CORRELATION OF AGE GROUP WITH COMPLICATION

		Complication				Total	Chi-square value	p-value
		N (n=7)		Y (n=11)				
Age group	< 30 yrs	3	42.9%	1	9.1%	4	2.822	0.244
	31-40 yrs	2	28.6%	5	45.5%	7		
	> 40-50 yrs	2	28.6%	5	45.5%	7		

FIGURE 29. CORRELATION OF AGE GROUP WITH COMPLICATION

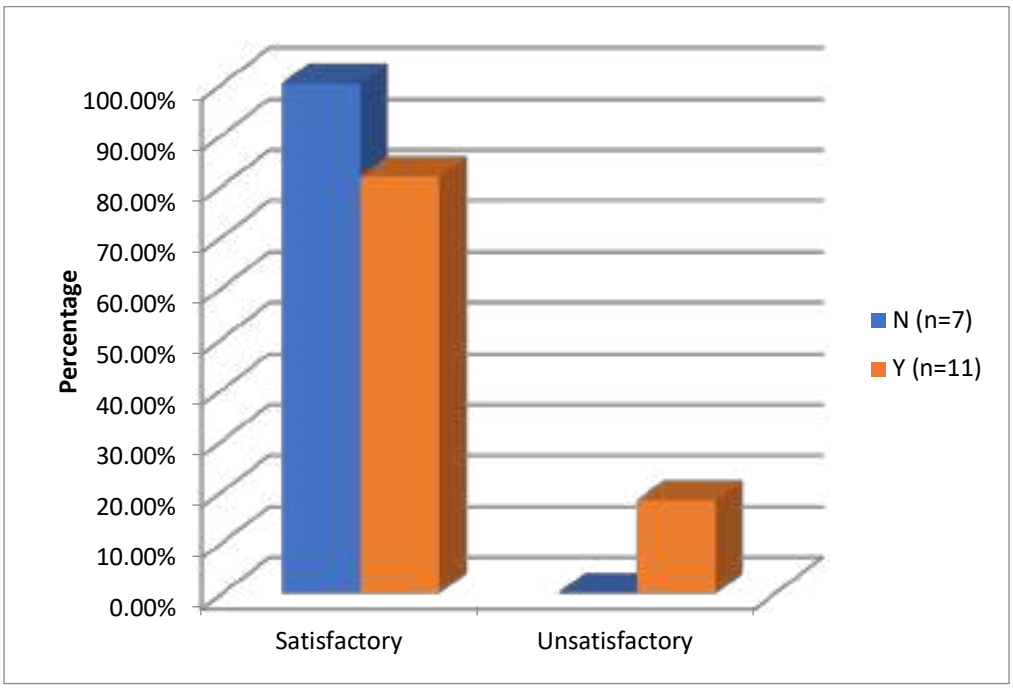


Out of 11 patients with complications, one patient was in age group of <30 years (9.1%), 5 patients each were present in age group of 31-40 and 41-50 years (45.5% each). However, this was not statistically significant (p value = 0.244).

TABLE 31. CORRELATION OF COMPLICATIONS WITH REDUCTION ADEQUACY

		Complication				Total
		N (n=7)		Y (n=11)		
Reduction (Reverse S sign)	Satisfactory	7	100.0%	9	81.8%	16
	Unsatisfactory	0	0.0%	2	18.2%	2

FIGURE 30. CORRELATION OF COMPLICATIONS WITH REDUCTION ADEQUACY

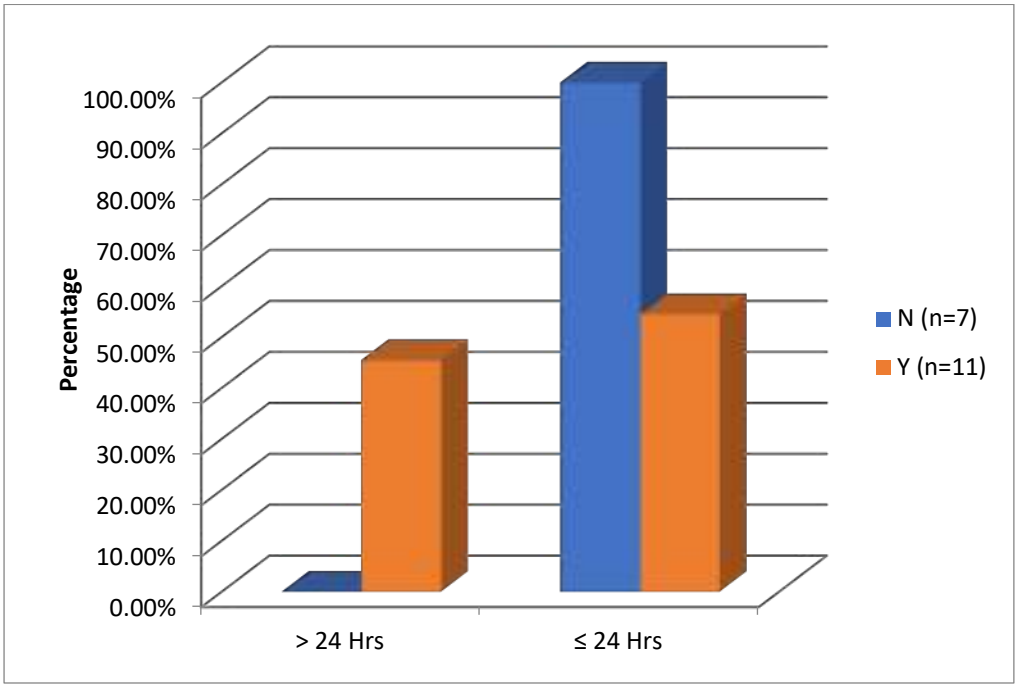


Out of the total 18 patients, 16 had satisfactory reduction of which 7 had no complications while 9 had some or the other complication. Of the total 2 patients with unsatisfactory reduction on postoperative radiograph, all 2 (100%) had some or the other complication. This shows importance of adequate reduction for prevention of complication in femoral neck fracture fixation.

TABLE 32. CORRELATION OF TIME TO SURGERY WITH COMPLICATIONS

		Complication				Total	Chi-square value	p-value
		N (n=7)		Y (n=11)				
Time to surgery < 24hrs	No	0	0.0%	5	45.5%	5	4.406	0.036
	Yes	7	100.0%	6	54.5%	13		

FIGURE 31. CORRELATION OF TIME TO SURGERY WITH COMPLICATIONS

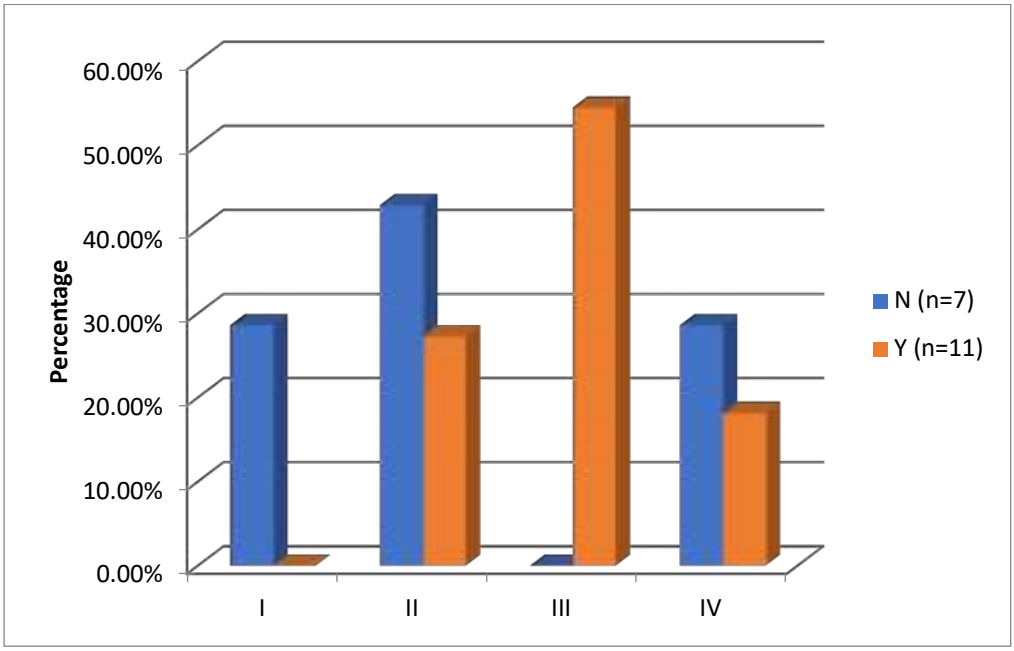


Out of 13 patients in whom surgery was done within 24hrs of injury, complications occurred in 6 patients (54.5%). Among 5 patients in whom surgery was done after 24 hrs of injury, complications occurred in all 5 (100%) patients. p value was found to be 0.036. Hence, the study showed that there is a highly significant correlation between time to surgery and occurrence of complications.

TABLE 33. CORRELATION OF FRACTURE GRADE WITH COMPLICATIONS

		Complication				Total
		N (n=7)		Y (n=11)		
Garden type	I	2	28.6%	0	0.0%	2
	II	3	42.9%	3	27.3%	6
	III	0	0.0%	6	54.5%	6
	IV	2	28.6%	2	18.2%	4

FIGURE 32. CORRELATION OF FRACTURE GRADE WITH COMPLICATIONS

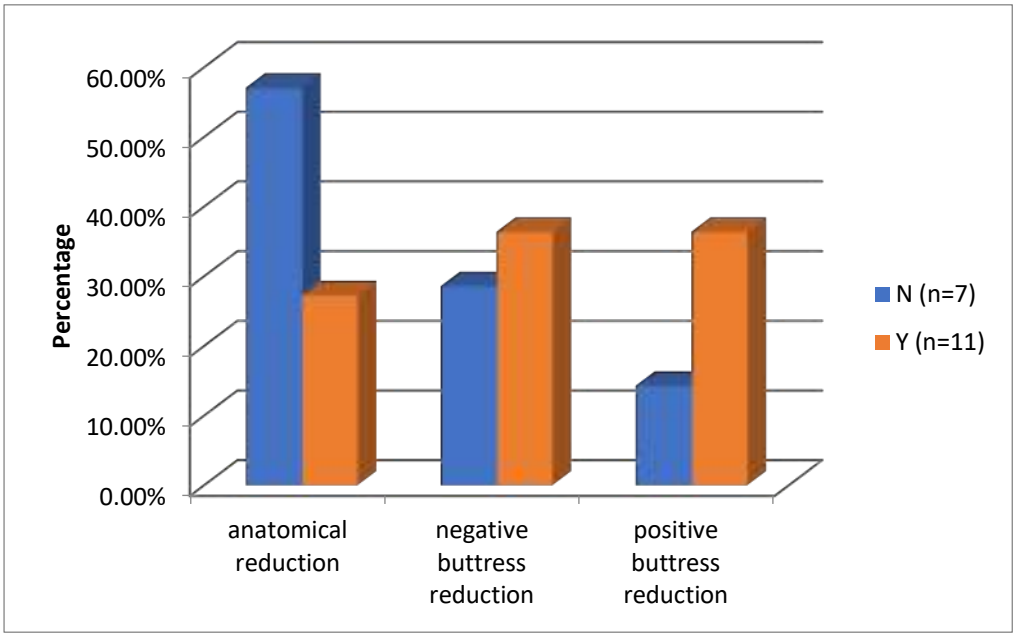


There were 8 patients (44.4%) with undisplaced fractures (Garden's grade I and II) and 10 patients (55.5%) with displaced fracture (Garden's grade III and IV). Amongst the group with undisplaced fracture only 3 (37.5%) out of 8 patients had complication, while amongst 10 patients with displaced fracture 8 (80%) out of 10. This shows significant association of displaced fracture with complications.

TABLE 34. CORRELATION OF TYPE OF REDUCTION WITH COMPLICATION

		Complication				Total
		N (n=7)		Y (n=11)		
Type Of Reduction	anatomical reduction	4	57.1%	3	27.3%	7
	negative buttress reduction	2	28.6%	4	36.4%	6
	positive buttress reduction	1	14.3%	4	36.4%	5

FIGURE 33. CORRELATION OF TYPE OF REDUCTION WITH COMPLICATION

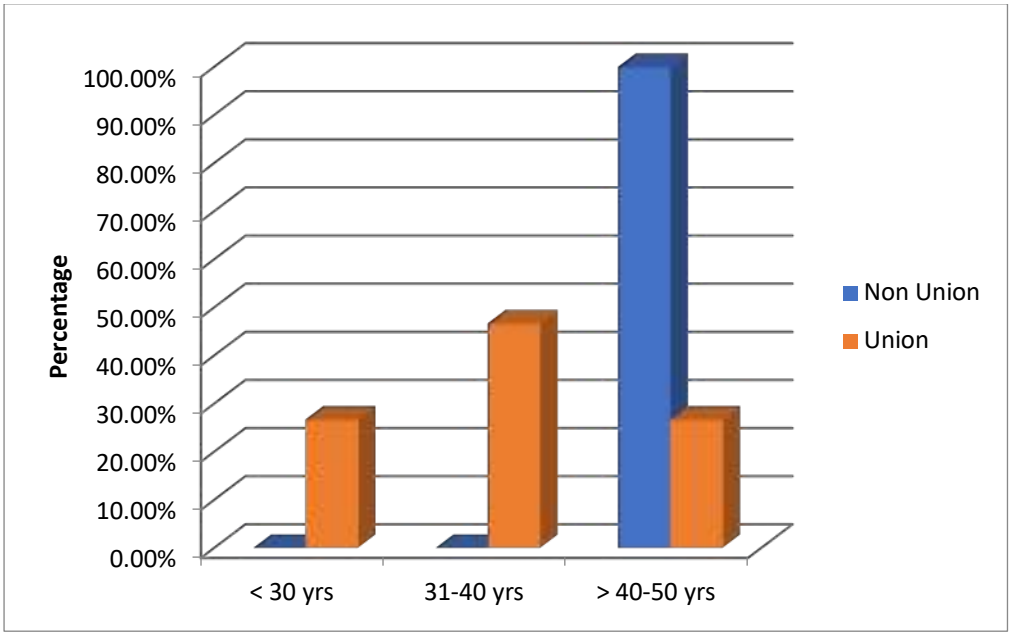


Out of total 7 patients with anatomical reduction, 4 (57.1%) had complications and out of the 6 patients with negative buttress reduction 4 (66.6%) had complications. However, amongst 5 patients with positive buttress reduction 4 (80%) patients had complications. Showing association of positive buttress reduction with increased chances of complications.

TABLE 35. CORRELATION OF RADIOLOGICAL OUTCOME WITH AGE GROUP

		Radiological Outcome				Total
		Non-Union		Union		
Age group	< 30 yrs	0	0.0%	4	26.7%	4
	31-40 yrs	0	0.0%	7	46.7%	7
	> 40-50 yrs	3	100.0%	4	26.7%	7
Total		3	100.0%	15	100.0%	18

FIGURE 34. CORRELATION OF RADIOLOGICAL OUTCOME WITH AGE GROUP

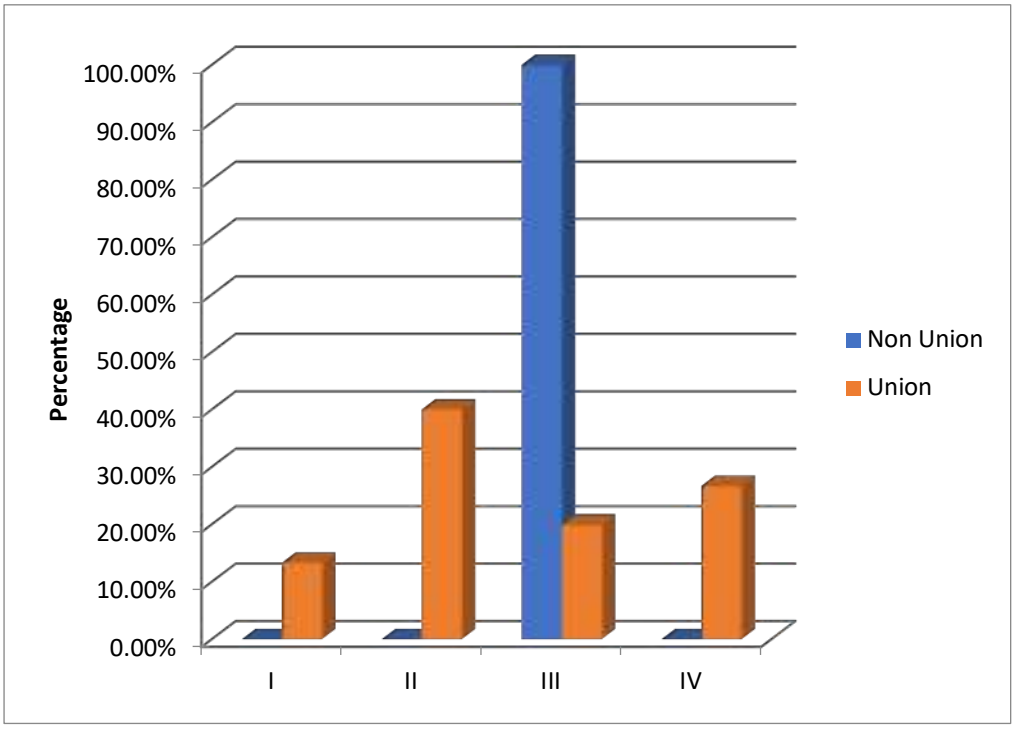


Out of the total 3 patients with radiological non-union all three (100%) belonged to 41 to 50 years of age group. This shows strong association of poor radiological outcome with increasing age.

TABLE 36. CORRELATION OF RADIOLOGICAL OUTCOME WITH DISPLACEMENT OF FRACTURE

		Radiological Outcome				Total
		Non-Union		Union		
Garden type	I	0	0.0%	2	13.3%	2
	II	0	0.0%	6	40.0%	6
	III	3	100.0%	3	20.0%	6
	IV	0	0.0%	4	26.7%	4
Total		3	100.0%	15	100.0%	18

FIGURE 35. CORRELATION OF RADIOLOGICAL OUTCOME WITH DISPLACEMENT OF FRACTURE

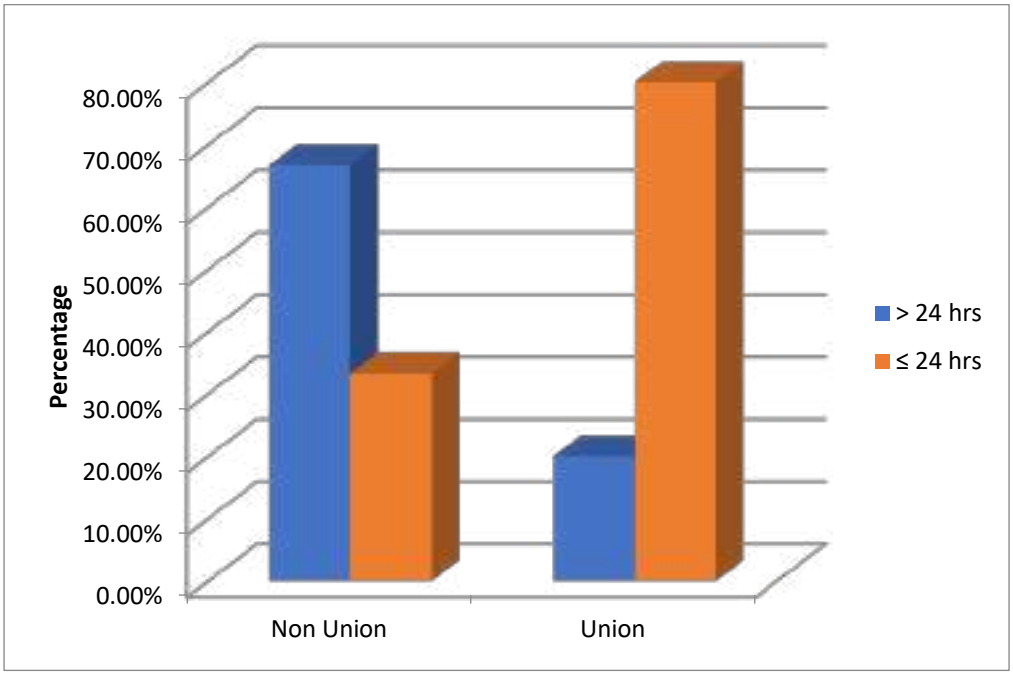


Out of the total 10 displaced fractures belonging to Garden grade III and IV, 3 (30%) had poor radiological outcome while out of the total 8 undisplaced fracture belonging to Garden grade I and II all (100%) had favourable radiological outcome. This shows association of fracture displacement with increased chances of poor radiological outcome.

TABLE 37. CORRELATION OF RADIOLOGICAL OUTCOME WITH TIME TO SURGERY

		Radiological Outcome				Total
		Non-Union		Union		
Time to surgery < 24hrs	> 24 hrs	2	66.7%	3	20.0%	5
	≤ 24 hrs	1	33.3%	12	80.0%	13
Total		3	100.0%	15	100.0%	18

FIGURE 36. CORRELATION OF RADIOLOGICAL OUTCOME WITH TIME TO SURGERY

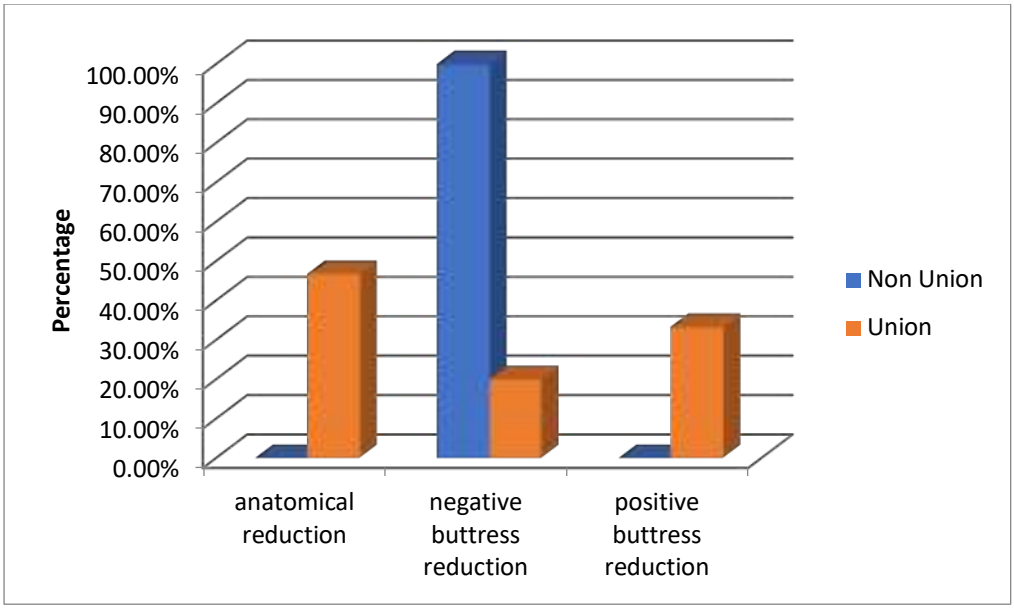


This table shows that amongst patients operated within 24 hours of trauma only 7.6% patient had poor radiological outcome while amongst patient operated beyond 24 hours of trauma 66.6% patient had poor radiological outcome. This shows increased chances of poor radiological outcome amongst cases operated more than 24 hours after the trauma.

TABLE 38. CORRELATION OF RADIOLOGICAL OUTCOME WITH TYPE OF REDUCTION

		Radiological Outcome				Total
		Non-Union		Union		
Type Of Reduction	anatomical reduction	0	0.0%	7	46.7%	7
	negative buttress reduction	3	100.0%	3	20.0%	6
	positive buttress reduction	0	0.0%	5	33.3%	5
Total		3	100.0%	15	100.0%	18

FIGURE 37. CORRELATION OF RADIOLOGICAL OUTCOME WITH TYPE OF REDUCTION



Out of the total 7 patients with anatomical reduction none all had favourable radiological outcome. Out of the total 6 patients with negative buttress reduction 50% had poor radiological outcome while out of total 5 patients with positive buttress reduction all had favourable radiological outcome. This shows that with negative buttress reduction there are increased chances of poor radiological outcome while anatomical reduction and positive buttress reduction had favourable radiological outcome.

DISCUSSION

For years, the internal fixation of young femoral neck fractures has been an ongoing debate on many fronts, including timing of surgery, type of reduction and method of fixation. Because of the high-energy nature of these injuries, with differences in bone quality, and physiologic age compared with the elderly femoral neck fracture, treatment of these fractures can be quite challenging. Regardless of choice of treatment, the goal is anatomic reduction and stable internal fixation.

The primary aim of internal fixation in these fractures is to achieve anatomical reduction as soon as possible in order to restore or preserve the precarious blood supply to the head of femur, more so in the younger age group and prevention of future complications such as avascular necrosis and non-union.[5]

The present study was conducted with recruitment of 18 patients of fracture neck of femur to know the functional and radiological outcome when treated with internal fixation. 18 patients were followed up and analysed according to study protocol. It was a prospective study carried on patients admitted in department of orthopaedics, Dayanand Medical College and Hospital, Ludhiana. Out of 18, 14 (77.8%) were male and 4 (22.2%) were female patients. The age of the patients was between 18 to 50 years, with the average age being 37.94 years with range of +/- 10.64 years. 11 patients were less than 40 years of age while 7 patients were of the age group more than 40 years. The study by Schweitzer et al.[87] had 29 patients with displaced femoral neck fracture out of which 22 (75.8%) were males and 7 (24.1%) were females with average age of 46.45 years +/- 11.59 years. The study by Khoo et al. had 53 patients, 39 males (73.6%) and 14 females (26.4%), with an average age of 42.1 years.[5] Higher incidence of fracture neck femur in young males can be explained by high energy mechanism of femoral neck fractures amongst young adults with young adult males being more involved in road traffic accidents as well as fall from height owing to Indian culture.

6 patients had roadside accident as mode of injury, with 8 sustaining injuries with a fall from height. Only 4 had history of trivial trauma being

domestic fall. Majority of the patients who sustained injury in a roadside accident and fall from height were less than 40 years and majority being males, showing that injury was high trauma injury in functionally active adults. Khoo et al.'s study had 36 patients with roadside accident as mode of injury out of 53, rest 17 sustaining injury as domestic fall.[5]

The fractures were classified as transcervical, subcapital and basal depending upon the position of fracture line along the neck of femur head. It was basal in 3 (16.7%) patients, subcapital in 7 (38.9%) patients and transcervical in 8 patients (44.4%). In study group of Khoo et al., 16 were the cases of basal neck fractures, 10 subcapital and 27 transcervical.[5]

Further emphasising on the role of displacement of fracture, they were classified into different stages based on the Gardens classification. 8 (44.4%) patients had un-displaced fracture having garden stage I & II, while 10 (55.5%) patients had displaced fractures falling under garden stage III & IV. Gumustas et al.[96] in their study had 39% un-displaced fractures and 61% displaced fractures while in the study of Zhao et al.[102] 23.6% patients had un-displaced fractures and 76.4% patients had displaced fractures.

Another classification is Pauwels classification, which is a biomechanical classification based on the vertical orientation of the fracture line and is commonly used to determine the appropriate treatment for femoral neck fractures, particularly among younger adults.[105] 7 (38.9%) patients had Pauwels type III, 8 (44.4%) patients had Pauwels type II and 3 (16.7%) had Pauwels type I. Higher the grade of Pauwels classification more vertical the fracture line, and it was proposed that the classification would be predictive of fixation failure or non-union with an increasing angle of fracture.[105] Zhao et al.[102] in their study 27.3% had Pauwels type III, 50.0% had Pauwels type II and 22.7% had Pauwels type I. In our study only one (5.6%) patient had undergone open reduction while rest other had closed reduction. Upadhyay et al.[32] who studied 92 patient undergoing internal fixation of fracture neck of femur, randomised patient in to two groups undergoing open and closed reduction, they did not find

any difference amongst both groups based on clinical or functional outcome.

Thirteen patients (72.2%) were operated within 24 hours of injury while five patients (27.8%) were operated after 24 hours. Gumustas et al.[96] in their study named “Femur neck fracture in young adults, is it really an urgent surgery indication” of 31 patients, had 14 patients operated within 24 hours of trauma and 17 patients operated after 24 hours of trauma. Upadhyay et al who had follow up of 92 patients in their study to find out result in terms of non-union and AVN in patients undergoing surgery in less than 48 hours or more than 48 hours of injury.[32]

Adequate reduction and stable fixation are two most important issues for percutaneous cannulated screw fixation. What constitutes an acceptable reduction is debatable. There are many proposed methods for confirmation of adequacy of reduction we have used garden alignment index and reverse s sign proposed by Lowell[106] for the same. Lowell demonstrated that the cortices of an anatomically aligned femoral head and neck will project shallow S- or reverse S-shaped curves on both x-ray views. Malalignment is demonstrated by a flattening of one curve and a sharp apex on the opposite side. These findings are usually easier to appreciate intraoperatively with fluoroscopy than are the primary compressive trabecular alignments needed to measure an alignment index. In our study only 2 (11.1%) patients had unsatisfactory while 16 patients have satisfactory reduction based on Lowell’s criteria.

Garden[107] described alignment index to measure the quality of reduction. This was based on measurement of bony trabecular alignment on the postoperative AP and lateral radiographs. On the AP view, the angle subtended by the central axis of the medial trabecular system in the head and the medial cortex should normally be 160 degrees. On the lateral view, the central trabecular axis in the head is in line with the femoral neck, an angle of 180 degrees. Garden[107] reported good results when the angle was between 155 and 180 degrees on either view. In our study mean garden alignment index on AP view radiograph was 167.33^{o} +/- 4.33^{o} while on the lateral view radiograph it was found to be 170.28^{o} +/- 6.88^{o}. Zhao et al.[102] in their study had mean

garden alignment index of 164.3 +/- 3.6^{o} on AP radiograph and 177.4 +/- 2.3^{o} on lateral view.

Type of reduction was assessed based on Gotfried et al.'s study[29]. In our study 38.9% patients had anatomical reduction, 27.8% patients had positive buttress reduction while 33.3% patients had negative buttress reduction. Zhao et al.[102] in their study had 37.3% had anatomical reduction, 31.8% had positive buttress reduction and 30.9% had negative buttress reduction.

The fracture union was seen by obliteration of fracture line and trabecular realignment on antero-posterior and lateral radiographs obtained serially with regular follow up of the patients. The radiological union occurred in 15 (83.3%) patients, with non-union seen in 3 (16.7%) patients. Upadhyay et al.[32] in their study with similar age group criteria found non-union rate upto 17.4% while Slobogean et al.[43] in their meta-analysis involving 1558 patients with similar age group found non-union rate upto 9.3%.

Avascular necrosis of femoral head following fracture neck of femur is one of the most dreaded complications. A diagnosis of AVN was made when the patient reported clinically sustained pain in the hip joint during the follow-up period, with subchondral sclerosis, cystic changes in femoral head or segmental collapse of the femoral head on simple radiographs. There were 4 patients in our study who developed AVN with rate being 22.2 %. Haidukewych et al. studied 82 patients out of whom osteonecrosis was seen in 17 (23%) patients.[20] Upadhyay et al. had overall incidence of 16 % out of 92 patients studied by them.[32] Slobogean et al.[43] in their metanalysis reported rate of AVN upto 15%. This is well supported by most of the literature and textbooks with Canale and Beaty mentioning the rate of AVN between 10 to 30 % in Campbell's operative orthopaedics 12th edition.[108]

There were 3 (16.7%) patients who had persistent limp even after fracture union, on radiographs at follow up it was found that they femoral neck shortening which was found by digitally superimposing unaffected hip over affected hip. Femoral neck shortening hampers abductor mechanism of the hip joint which further leads to persistent limp in the

patients with femoral neck fractures. Zlowodozki et al.[33] reported 27% incidence of femoral neck shortening amongst patient with displaced femoral neck fractures. They further emphasised its significant role in quality of life post femoral neck fractures.

Correlation of age with clinical (functional outcome and complications) and radiological outcome.

Functional assessment of all patients was done at 6 months of follow up using modified Harris hip score. Generic Harris hip score includes a physical examination component which has high inter-observer variability.[109] This component of physical examination was removed, and a modified version of HHS was devised and brought into use. The validity of same in the Indian scenario was confirmed by Kumar et al in 2017[110] by comparing outcome of total hip replacement using generic scale and its modified version. Modified version gave maximum score out of 91 which was then multiplied by 1.1 to find final score out 100 and is then interpreted accordingly. Use of modified Harris hip score had an advantage of telephonic follow up, considering COVID 19 pandemic. The modified Harris hip score was excellent (>90) in 6 patients, good (80-89) in 7, reasonable (70-79) in 2 and poor in 3 patients (<69). All the patient with excellent functional outcome belonged to age group less than 41 years of age group. All the patient with poor functional as well as radiological outcome belonged to more than 40 year of age group. Out of the 7 patients with good outcome 4 belonged to age group less than 41 years while rest 3 belonged to 41-50 years of age group. This indicates towards increased trends of poor functional outcome with increasing age however its statistical significance could not be proven. Evans et al. also showed that younger age group patient had better functional outcome post-operatively.[111] However, there was no statistically significant (p value = 0.244) association between age and complications.

Correlation of sex with clinical (functional outcome and complications) and radiological outcome.

The present study shows that there is no statistically significant correlation between gender and functional outcome in internal fixation of fracture neck of femur. In total 6 patients with excellent outcomes, 4 were males and 2 were females. 6 (85.7%) patients out of 7 with good outcomes were male and 1 (50%) out of 2 patients with fair outcome were male. The p value is >0.05 for correlation between sex and complications as well.

Correlation of associated comorbidities with clinical (functional outcome and complications) and radiological outcome.

Out of three patients with diabetes mellitus type 2, two patients had presence of complications while two patients had poor functional as well as radiological outcome. This shows increase chances of poor functional as well radiological outcome but correlation with complications was not statistically significant. This is supported by Jesse et al.[112] in their study they found no correlation between comorbidities and clinical as well as functional outcome.

Correlation of mechanism of injury with clinical (functional outcome and complications) and radiological outcome.

Out of the 14 patients with high energy trauma in the form of fall from height and road traffic accident, 6 (42.8%) had excellent functional outcome and 6 (42.8%) had good functional outcome while only 2 (14.2%) had poor functional outcome. Amongst patients with low energy trauma in the form of domestic fall, only 25% had good functional outcome while 50% patients had reasonable and 25% had poor functional outcome. There was trend towards lower functional outcome in patients with low energy trauma which may be attributed to preinjury comorbidity and activity. There was no statistically significant association between complications and mechanism of injury. In the same way poor radiological outcome was equally associated with low energy trauma as well as high energy trauma. This is supported by Schweitzer et al.[87] in their study they found lower energy trauma was associated with increased chances of poor clinical as well as radiological outcome but

after adjustment of age in logistic regression model they found trauma energy was not an independent determinant of clinical outcome.

Correlation of site of fracture with clinical (functional outcome and complications) and radiological outcome

Out of 6 patients with excellent functional outcome 3 each belonged to subcapital group and transcervical group. Amongst 7 patients with good functional outcome 14.3% belonged to basicervical group, 28.6% to subcapital group and 57.1% to transcervical group. Amongst patient with reasonable outcome all were from subcapital group while out of the 3 patients with poor functional outcome 2 belonged to basicervical group and 1 belonged to transcervical group. Out of the 3 patients with basicervical fracture two had poor functional outcome as the anatomical reduction could not be achieved this resulted in negative buttress reduction. There was no statistically significant correlation of complications and radiological outcome with site of fracture. This is well supported by most of the literature and textbooks with Rajan and Parker mentioning that location of intracapsular fracture has not shown any influence on management and outcome femoral neck fracture in Rockwoods and Green's fractures in adults 9th edition.[113]

Correlation of displacement of fracture with clinical (functional outcome and complications) and radiological outcome.

Out of the 6 patients with excellent outcome 4 belonged to un-displaced group (garden I & II), while out of the 3 with poor outcome all of them belonged to displaced group (garden III & IV). Out of the 11 patients with complications, 8 belonged to displaced group. Same trend was present in radiological outcome where all three with non-union belonged to displaced group. This shows increased chances of poor clinical outcome and radiological outcome with displacement of fracture; however, its statistical significance could not be determined. Kumar et al.[84] in their study concluded that irrespective of age un-displaced group went into union and had good functional results, while those belonging to displaced groups results were not very encouraging. Rate of complications was higher in displaced group as compared to the average

rate of the study cohort. The same was concluded by Koaban et al.[114] in their study but was statistically insignificant (p value 0.209).

Correlation of Pauwels classification with clinical (functional outcome and complications) and radiological outcome.

Our study did not find any correlation between Pauwels type and functional outcome. However, incidence of non-union was higher in higher grade of Pauwels type with 66.7% with non-union belonging to Pauwels type III and 33.3% with non-union belonging to Pauwels type II. Correlation between complications and Pauwels grading was found to statistically insignificant (p value >0.5). Pauwels believed that risk of displacement, and thus non-union, increased with femoral neck fracture line inclination. However, Parker and Dynan[115] found no relationship between Pauwels fracture type and rate of non-union. Calandruccio and Anderson[116] did not observe a higher rate of avascular necrosis with increasing Pauwels inclination angle. These findings are contrary to Pauwels' notion of more unfavourable biomechanics and healing potential at fracture sites with steeper inclination angles.

Correlation of fracture reduction with clinical (functional outcome and complications) and radiological outcome.

In our study only 2 (11.1%) patients had unsatisfactory while 16 patients has satisfactory reduction based on Lowell's criteria.[106] In our study mean garden alignment index on AP view radiograph was 167.33^{o} +/- 4.33^{o} while on the lateral view radiograph it was found to be 170.28^{o} +/- 6.88^{o}. 56.2% of patients who had satisfactory reduction suffered from complications and 100% of patients who had unsatisfactory reduction, suffered from complications. Out of the three patients with poor functional outcome 66.7% belonged to unsatisfactory reduction group. Incidence of poor functional outcome with satisfactory reduction was 6.2% while that in unsatisfactory reduction was 100%. Hence, the association between adequacy of fracture reduction and clinical outcome and radiological outcome could be significant, however in our study it was not possible to calculate statistical significance as only 2 patients has unsatisfactory reduction. Upadhyay et al, concluded that poor fracture reduction did not influence AVN though they directly

contributed to non-union.[32] Also, in a study by Khoo et al. adequacy of fracture reduction with subsequently stable fixation was achieved in 71.7% (38 of 53 patients) while inadequate reduction occurred in 28.3% (15 of 53 patients). There were 6 cases of AVN in the adequately reduced group (16%) as opposed to 3 cases of AVN in inadequately reduced group (20%). They found no significant relationship between adequacy of fracture reduction and risk of avascular necrosis (p value = 0.774).[5]

Correlation of type of reduction with clinical (functional outcome and complications) and radiological outcome.

"Rockwood and green's fractures in adults" says failure to achieve stable anatomical reduction is not under control of surgeon. Based on principles of "Gotfried's reduction"[29], three groups of reduction was formed. Out of the 7 patients with anatomical reduction only one (14.2%) patient had reasonable outcome rest all had good or excellent outcome. Out of the 5 patients with positive buttress reduction only one (20%) patient had reasonable outcome rest other had excellent or good outcome. Out of the 6 patients with negative buttress reduction, 3 (50%) patients had poor functional outcome while 2 had good and 1 had excellent outcomes. On comparing correlation with radiological outcome, out of three patients with non-union all three belonged to negative buttress reduction group while all the patients with anatomical reduction or positive buttress reduction went into union. Thus, the rate of non-union was found to be higher in negative buttress reduction as compared to other two groups. However, the limitations of our study was small sample size. Zhao et al.[102] in their study found that positive buttress reduction as well as anatomical buttress reduction had similar complications rate while patients with negative buttress reduction had higher complications rate as well as reoperations rate. Thus, we conclude that for irreversible femoral neck fractures, if positive buttress position reduction has been achieved intraoperatively, it is not necessary to pursue anatomical reduction; however, negative reduction needs to be avoided.

Correlation of time to surgery with clinical (functional outcome and complications) and radiological outcome.

In our study total 5 patients were operated beyond 24 hours of injury. Out of the 5 patients, 2 (40%) patients had poor functional outcome. Out of the 13 patients operated within 24 hours of injury, 5 had excellent, 6 had good, 1 reasonable and one (7.6%) had poor outcome. On analysis of correlation, we found statistically significant (p value 0.036) correlation between complications and time to surgery. On correlating radiological outcome with time of surgery, we found that out of 5 patients operated after 24 hours of trauma, 2 had non-union while out of 13 patients operated within 24 hours of trauma only one had non-union. In our study out of 4 cases of AVN, 2 were those operated beyond 24 hours of trauma. Thus, incidence of AVN was 40% amongst those operated beyond 24 hours as compared to 15.3% amongst those operated within 24 hours. Similarly, incidence of non-union was higher amongst those who had delayed surgery as compared to those operated early. Almost similar and comparative result was observed by, Manoj et al.[93] who performed retrospective study on 40 patients in Indian tertiary care hospital, of age group below 60 years. Like our study, they concluded that there was no difference in functional outcome of patients between delayed fixation group and early fixation group. However, they found rate of complication like AVN was higher in those operated beyond 48 hours of trauma. In their study they found that there was no functional difference between those who developed AVN on radiographs and those who did not. Similar findings were observed in our study regarding AVN and functional outcome. Out of 4 patients in our study who developed AVN on radiographs, 3 had good functional outcome while one had fair/reasonable functional outcome.

Similarly, Kumar et al.[84] in their study in Indian scenario found that delay in internal fixation of intracapsular fracture for more than 48 hours led to increased chances of AVN. This is also supported by Khoo et al.[5] in their study, they found higher incidence of complication like AVN with increasing time lapse. However, this is in contradiction to study by Gumustas et al.[96] entitled “fracture neck femur in young adults, is it

really an urgent surgical indication." They found no statistically significant difference between two groups of those operated beyond 24 hours and before 24 hours of trauma. Upadhyay et al.[32] in their study of 92 patients below 50 years of age, found no difference rate of AVN amongst those operated beyond or before 48 hours with overall AVN rate of 16%.

A limitation of our study was the small number of subjects. Femoral neck fractures are not common in young adults, so acquisition of such a statistically significant sample size would require a large multi-centre trial. Aforesaid limitation may also be partly attributed to COVID19 pandemic which affected both recruitment and follow up of cases. A prospective, randomized clinical trial involving multiple sites is certainly possible.

SUMMARY AND CONCLUSION

The present study was designed to find out the functional and radiological outcome in internal fixation of fracture neck of femur. It was a prospective study carried on patients admitted in Department of Orthopaedics, Dayanand Medical College and Hospital, Ludhiana.

1. The mean age in our study was 37.94 years with 61.1% below 41 years of age. The association of age with functional outcome showed increasing trend towards poor functional with increasing age. The was no statistically significant (p value 0.244) relation between age and complications. However, all patient with poor radiological outcome belonged to age group more than 40 years of age.
2. There were 14 (77.8%) male and 4 (22.2%) female patients. Sex of the patient had no relation with functional, radiological outcome or complications. Prevalence of male of male amongst patient might be attributed to mechanism of injury and Indian culture.
3. Majority of patients (77%) had high energy trauma in the form of either fall from height or roadside accident. Patients with low energy trauma in this age group had increasing chances (14.2% vs 25%) of poor functional outcome probably owing to preinjury activity level or comorbidity.
4. Average time to union was 4.2 months (3 to 6 months). Out of the total 18 patients, 3 patients had non-union while rest other had fracture united. Bringing the overall rate of non-union in our study to be 16.7%.
5. The medically comorbid patient had increased chances of poor functional as well as radiological outcome. This can be attributed to the fact that patients with medical comorbidities had a compromised functional capability. There was no statistically significant correlation between complications and comorbidity (p value 0.829).
6. Correlation between anatomical location of fracture, as in basal, transcervical or subcapital with functional outcome, fracture union or

complications was found to be statistically insignificant (p value 0.408)

7. Fracture displacement was classified according to Garden's classification. Out of 11 patients with complications, 8 belonged to displaced group. Out of three patients with poor functional outcome all belonged to displaced groups. All of the non-union patients belonged to displaced group. This signifies greater complications as well as poorer functional and radiological outcome with increasing displacement.
8. Pauwels classification was found to be predictor of increasing incidence of non-union with increasing grade of fracture. However, correlation of complications and functional outcome with Pauwels classification could not be established.
9. Lowells criteria for satisfactory reduction was found to be good predictor of fixation failure as out of two patients with broken reverse s sign both had fixation failure and non-union.
10. Using "Gotfried's reduction" principle for femoral neck fracture is a novel concept our study included. Not much of the studies have been conducted applying these concepts on femoral neck fracture in Indian scenario. Inability to achieve anatomical reduction should not be considered as failure, as achievement of positive buttress reduction had equally good results in our study while achievement of negative buttress reduction should be avoided. There should be compromise between biological reduction and anatomical reduction.
11. Time to surgery is an important and much discussed part of the treatment protocol of femoral neck fracture fixation. Time to surgery had statistically significant correlation with complications. (p value 0.036). Chances of poor radiological outcome increases with increased time lapse before surgery. However functional outcome remained unaffected with time lapsed before surgery. Chances of AVN increased significantly with time lapsed before surgery.
12. Use of modified Harris Hip score is a novel concept which excludes "unreliable" considered portion of Harris Hip Score that is the portion of physical examination. We have used the novel concept of

modified Harris hip score for functional evaluation. This novel score will specially play an important role in newer studies due to ease of telephonic follow up. Also considering present and indefinite times of COVID 19 pandemic, modified Harris hip score will prove to be boon for researchers.

13. Hence the functional outcome is not related to the gender, location of fracture, Pauwels grading, or time to surgery while it is better in younger patients, amongst those without comorbidity, and those with anatomical reduction or positive buttress reduction.
14. The present study concluded that risk factors for non-union includes unsatisfactory reduction, delay in surgery, fracture displacement, higher Pauwels grade and negative buttress reduction. Similarly, the risk factors for complications like AVN, femoral neck shortening, screw back out include displacement of fracture, negative buttress reduction, and time to surgery.

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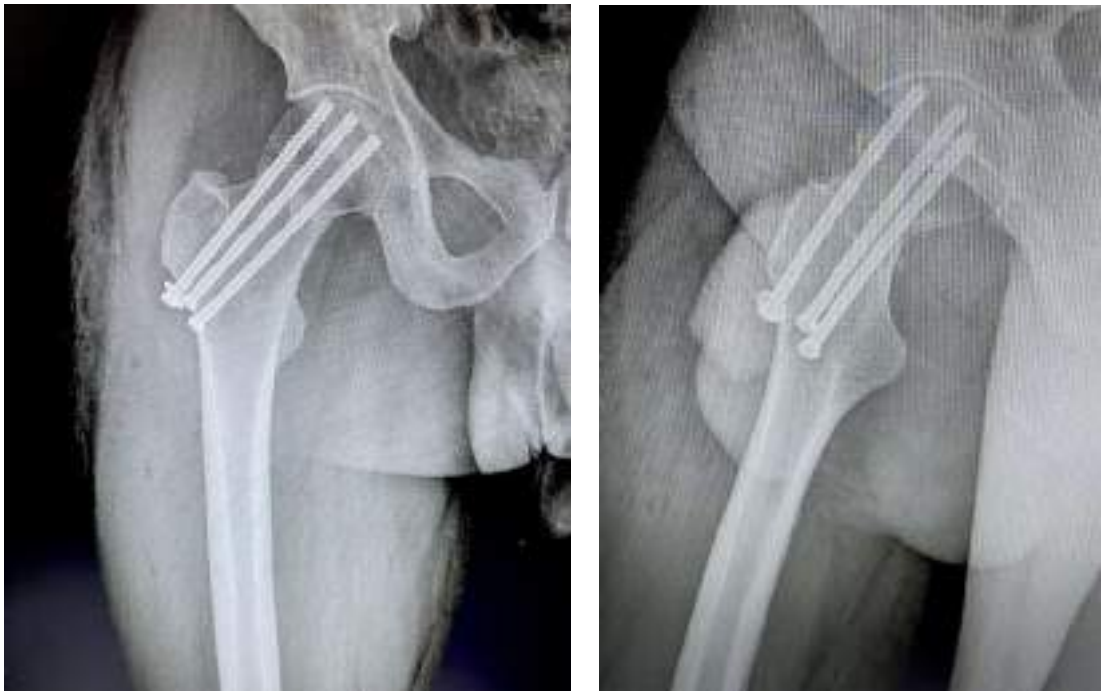
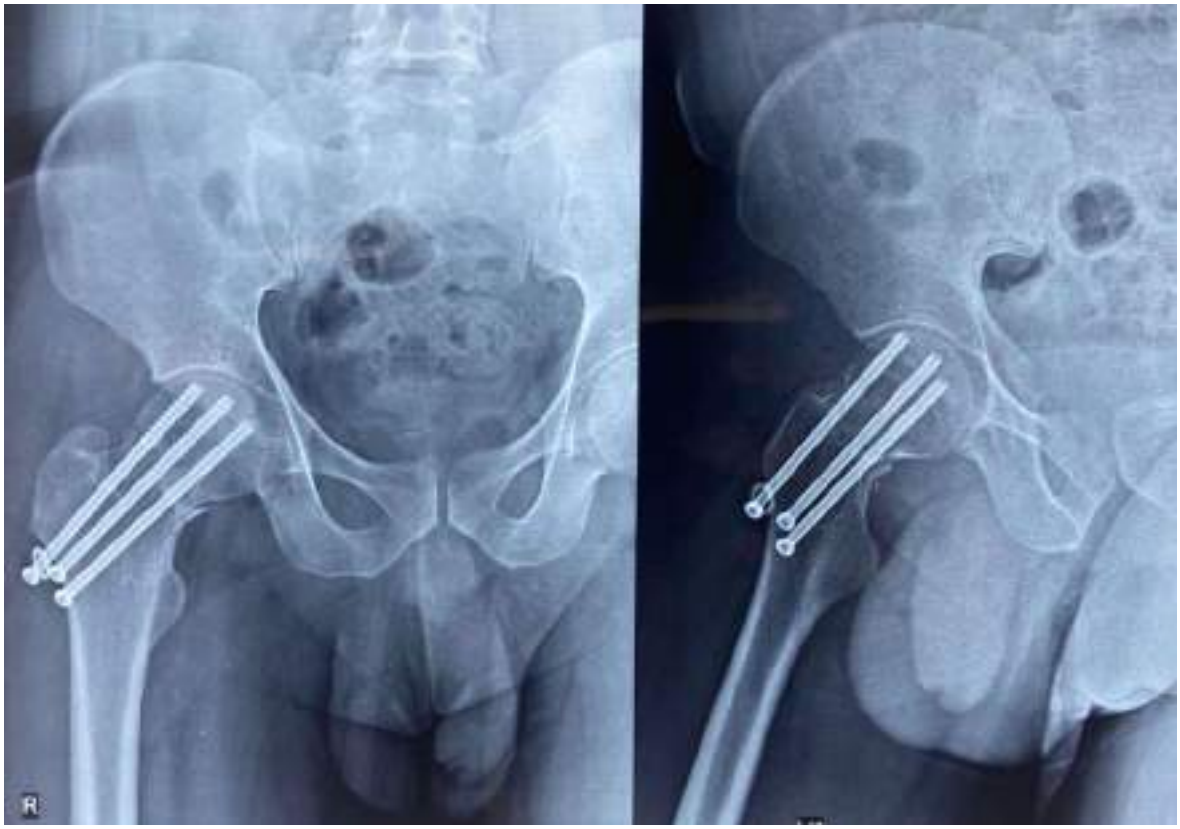
Case 1. Patient with excellent functional outcome.

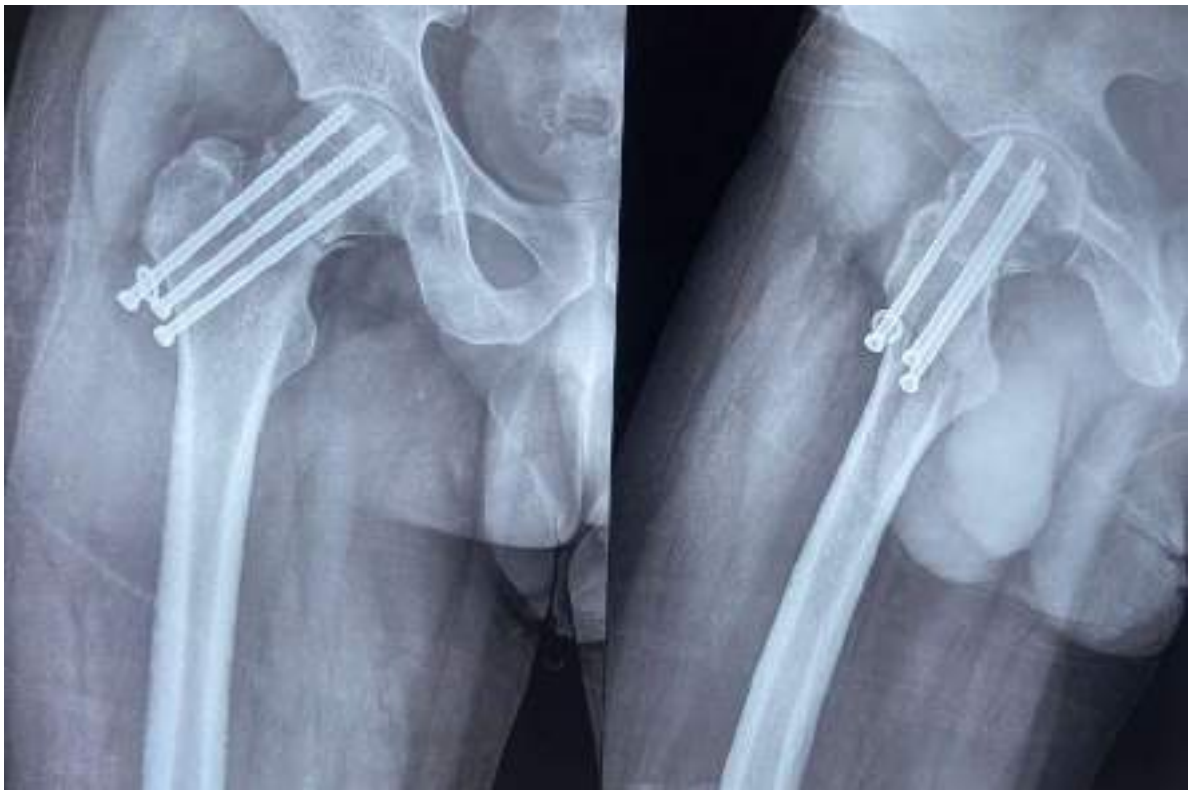
PICTURE 2. PREOPERATIVE AP VIEW AND LATERAL VIEW



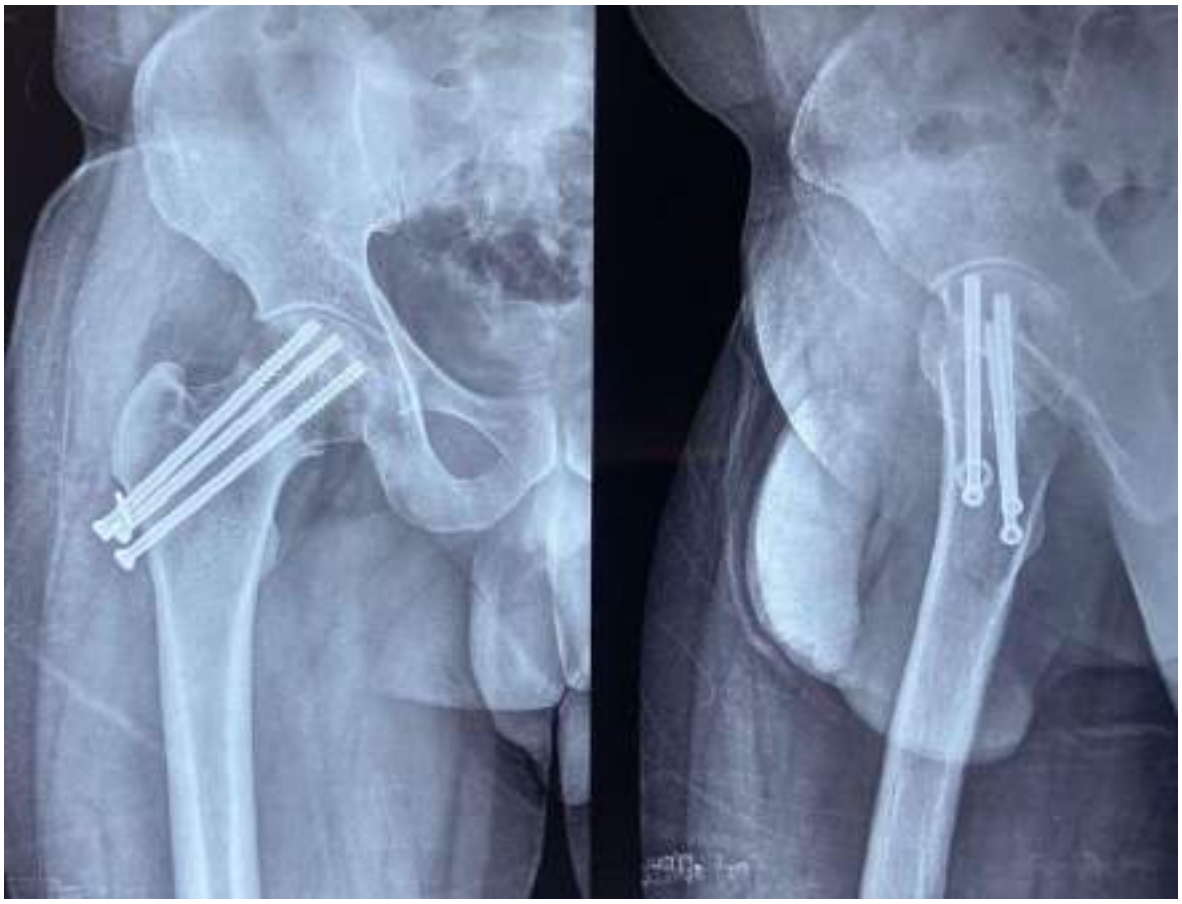
PICTURE 3. POST-OPERATIVE AP VIEW AND LATERAL VIEW WITH POSITIVE BUTTRESS REDUCTION.



PICTURE 4. AT 4 WEEKS FOLLOW UP - AP VIEW AND LATERAL VIEW



PICTURE 5. AT 3 MONTHS FOLLOW UP - AP VIEW AND LATERAL VIEW



PICTURE 6. AT 6 MONTHS FOLLOW UP - AP VIEW AND LATERAL VIEW SHOWING UNION AND SCREW BACKOUT

PICTURE 7. AT 6 MONTHS FOLLOW UP – SQUATTING AND CROSSED LEG SITTING

Case 2. Patient with good functional outcome

PICTURE 8. PREOPERATIVE AP VIEW

PICTURE 9. POST-OPERATIVE AP AND LATERAL VIEW WITH ANATOMICAL REDUCTION

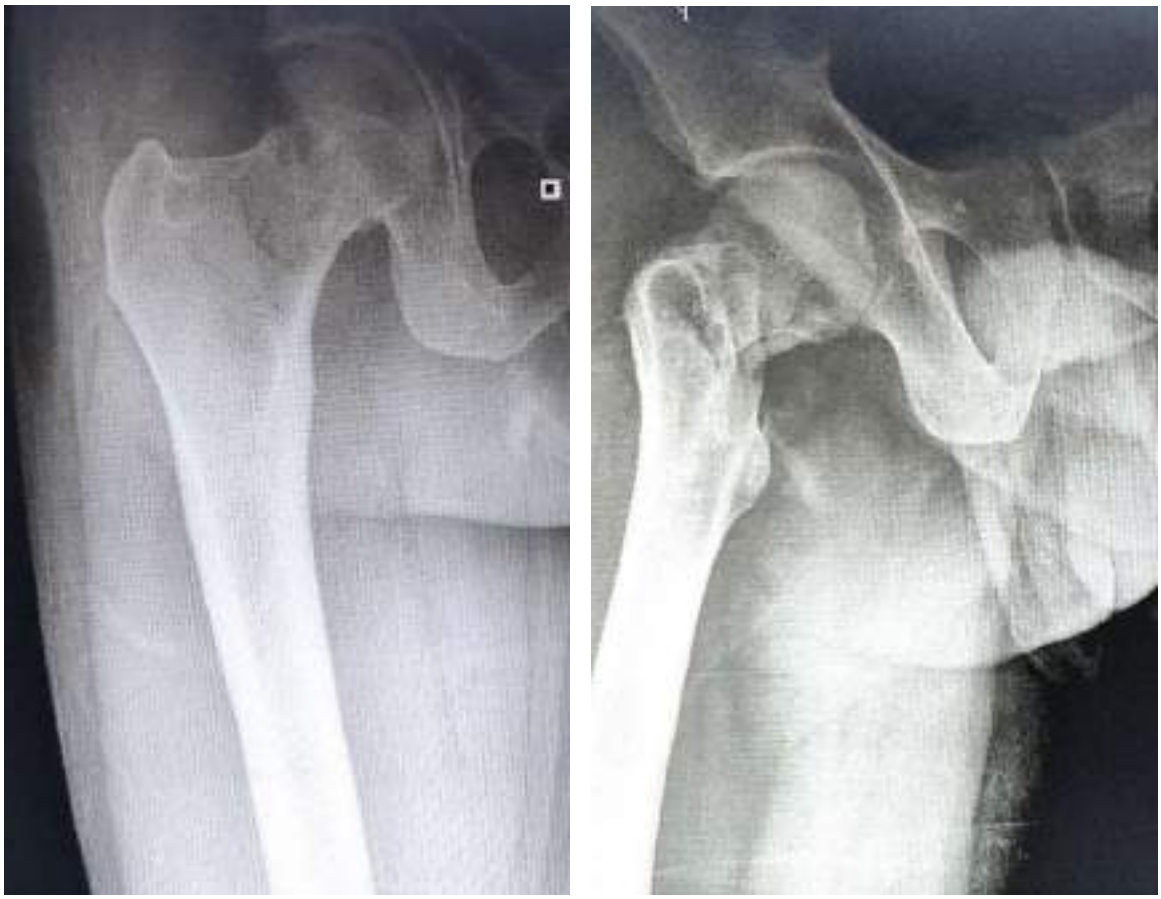
PICTURE 10. AT 4 WEEKS FOLLOW UP - AP AND LATERAL VIEW

PICTURE 11. AT 3 MONTHS FOLLOW UP - AP AND LATERAL VIEW SHOWING UNION

PICTURE 12. AT 6 MONTHS FOLLOW UP - AP AND LATERAL VIEW SHOWING SIGNS OF AVN

PICTURE 13. AT 6 MONTHS FOLLOW UP – SQUATTING AND CROSSED LEG SITTING

Case 3. Patient with good functional outcome.



PICTURE 14. PREOPERATIVE AP VIEW AND LATERAL VIEW

PICTURE 15. POST-OPERATIVE AP AND LATERAL VIEW

PICTURE 16. AT 3 MONTHS FOLLOW UP - AP AND LATERAL VIEW

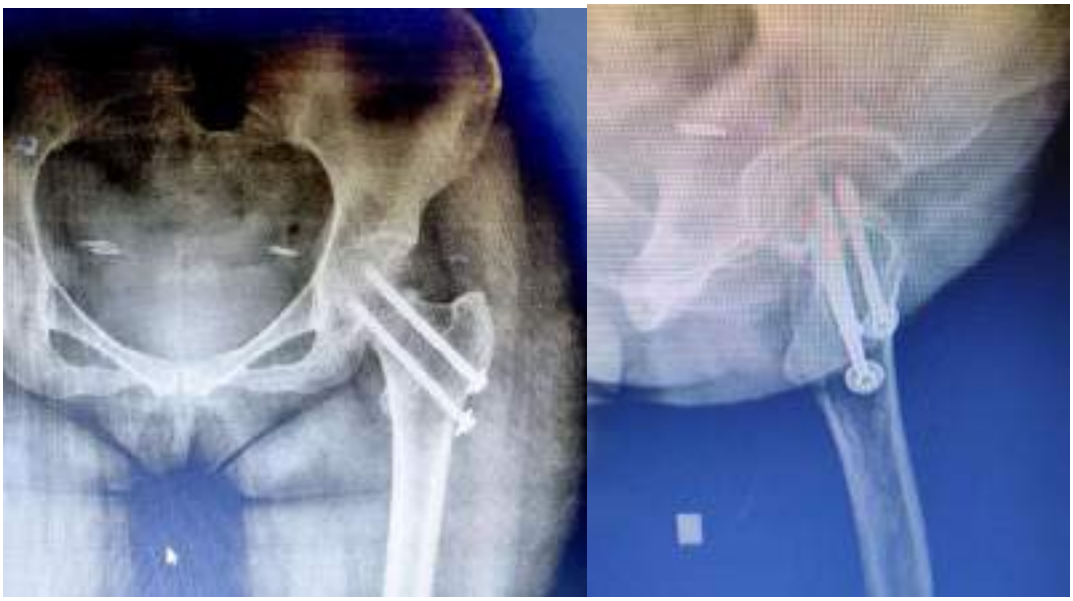
PICTURE 17. AT 6 MONTHS FOLLOW UP - AP AND LATERAL VIEW SHOWING UNION AND SIGNS OF AVN

PICTURE 18. AT 6 MONTHS FOLLOW UP – SQUATTING AND CROSSED LEG SITTING

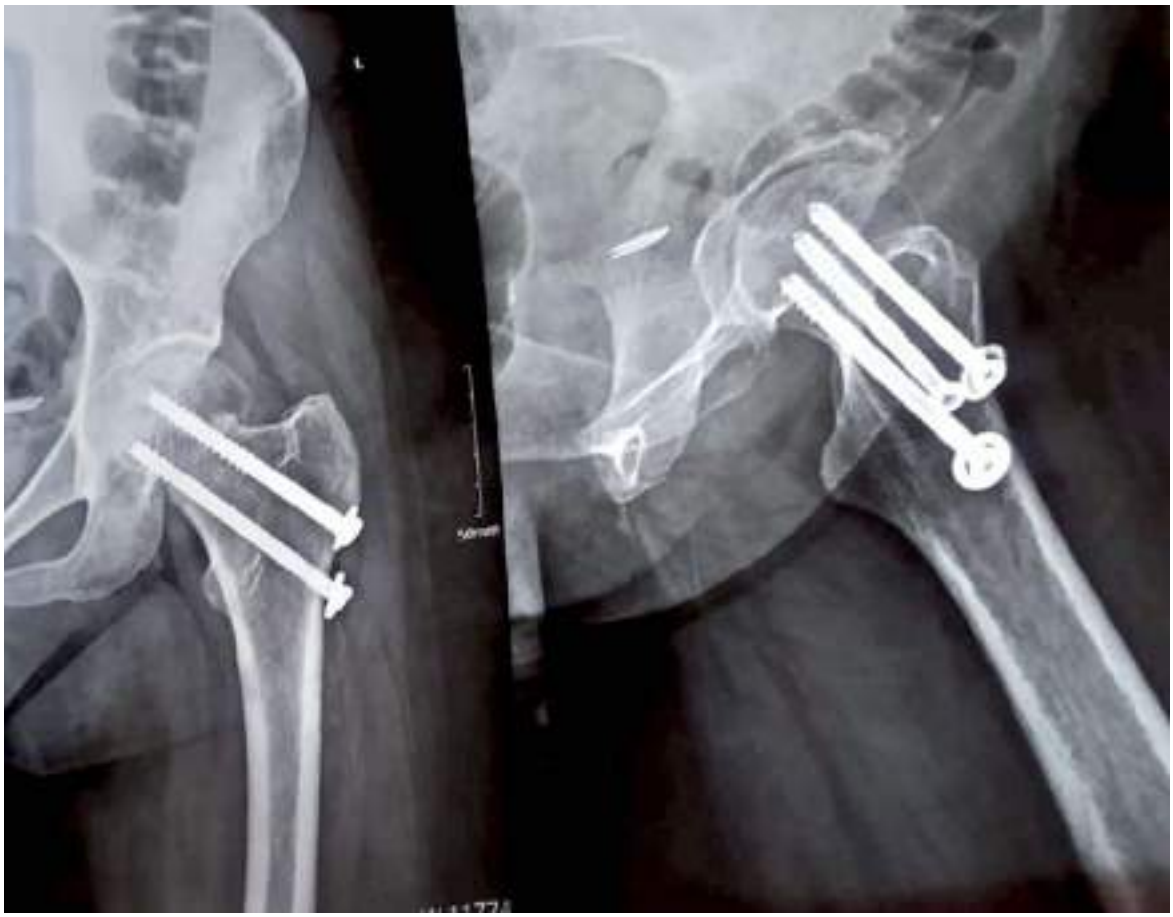
Case 4. Patient with reasonable/fair functional outcome.

PICTURE 19. PREOPERATIVE AP VIEW

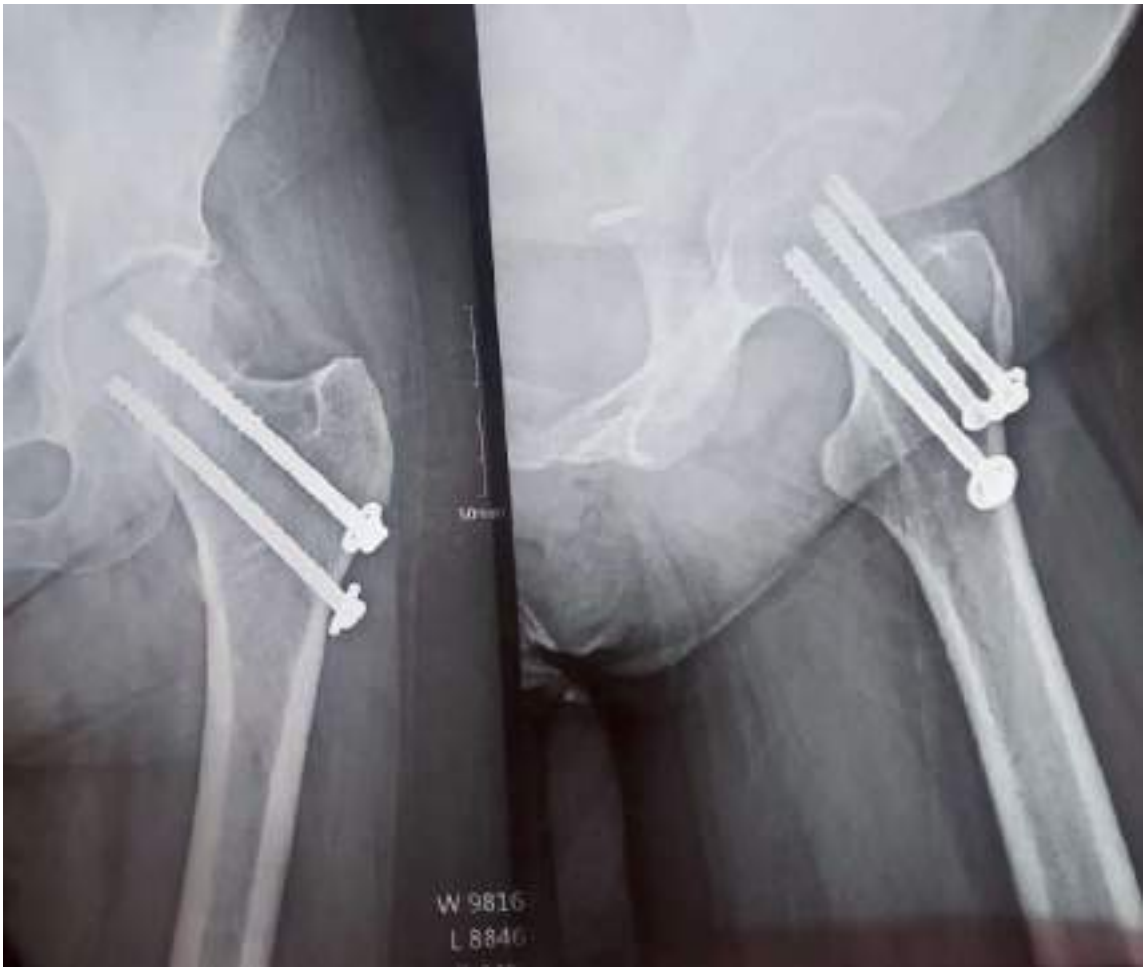
PICTURE 20. POST-OPERATIVE AP AND LATERAL VIEW SHOWING VALGUS IMPACTED FRACTURE WITH INSITU PINNING.



PICTURE 21. AT ONE MONTH, AP AND LATERAL VIEW



PICTURE 22. AT 3 MONTHS FOLLOW UP - AP AND LATERAL VIEW SHOWING UNION



PICTURE 23. AT 6 MONTHS FOLLOW UP - AP AND LATERAL VIEW

PICTURE 24. AT 6 MONTHS FOLLOW UP – SQUATTING AND CROSSED LEG SITTING

KEY TO MASTER CHART

AP	-	ANTERO-POSTERIOR
AVN	-	AVASCULAR NECROSIS
DF	-	DOMESTIC FALL
DM II	-	DIABETES MELLITUS TYPE II
F	-	FEMALE
FFH	-	FALL FROM HEIGHT
M	-	MALE
mHHS	-	MODIFIED HARRIS HIP SCORE
RTA	-	ROAD TRAFFIC ACCIDENT

Sno.	MRD	Name	Age	Sex	Assoc comorbidities	Personal History		Mech of injury	Side	Site of fracture	Pauwel type	Garden type	Reduction Method	No.of screws	Arrangement of screws	Reduction (Reverse S sign)	Garden alignment index	
						Alcoholic	Smoker										AP view	Lateral view
1	967655	GS	37	M	Nil	Yes	No	FFH	Left	Transcervical	II	III	Closed	3	Inverted triangle	Satisfactory	165	170
2	752385	VK	50	M	DM II	No	No	FFH	Right	Basicervical	III	III	Closed	3	Inverted triangle	Satisfactory	170	171
3	753495	VK	34	M	Nil	No	No	RTA	Right	Transcervical	III	II	Closed	3	Inverted triangle	Satisfactory	165	166
4	759014	AT	36	F	Nil	No	No	FFH	Left	Subcapital	II	IV	Closed	3	Inverted triangle	Satisfactory	161	169
5	779225	SY	39	M	Nil	No	No	RTA	Left	Transcervical	I	III	Closed	3	Inverted triangle	Satisfactory	166	169
6	780433	K	18	M	Nil	No	No	FFH	Left	Transcervical	II	II	Closed	3	Inverted triangle	Satisfactory	165	179
7	787277	MPG	50	M	Nil	No	Yes	RTA	Left	Subcapital	I	II	Closed	3	Inverted triangle	Satisfactory	168	173
8	795092	SS	48	M	DM II	No	No	DF	Right	Transcervical	III	II	Closed	3	Inverted triangle	Satisfactory	166	173
9	794096	S	19	F	Nil	No	No	FFH	Left	Subcapital	II	I	Closed	3	Inverted triangle	Satisfactory	170	177
10	906327	HSD	38	M	Nil	No	No	FFH	Right	Subcapital	I	I	Closed	3	Inverted triangle	Satisfactory	160	162
11	904800	BK	50	M	Nil	Yes	No	RTA	Left	Transcervical	III	III	Open	3	Inverted triangle	Unsatisfactory	168	185
12	919271	NK	42	M	DM II	No	No	DF	Right	Basicervical	II	III	Closed	3	Inverted triangle	Unsatisfactory	165	173
13	847385	SS	50	F	Nil	No	No	DF	Left	Subcapital	II	II	Closed	3	Inverted triangle	Satisfactory	171	167
14	926876	MK	24	F	Nil	No	No	RTA	Right	Subcapital	III	IV	Closed	3	Triangle	Satisfactory	173	156
15	957881	BS	29	M	Nil	Yes	No	FFH	Left	Transcervical	II	III	Closed	4	Inverted triangle with pauwels screw	Satisfactory	169	160
16	748333	GS	36	M	Nil	No	No	FFH	Right	Transcervical	III	IV	Closed	3	Inverted triangle	Satisfactory	168	169
17	941440	BS	50	M	Nil	Yes	No	RTA	Left	Basicervical	III	IV	Closed	3	Inverted triangle	Satisfactory	165	176
18	886466	PS	33	M	Nil	Yes	No	DF	Right	Subcapital	II	II	Closed	3	Inverted triangle	Satisfactory	177	170

Sno.	MRD	Type Of Reduction	Time to surgery		Functional Outcome(mHHS)	Radiological Outcome	Time to union	Complications	Secondary Procedure
			<24hrs	>24hrs		Union Or nonunion			
1	967655	positive buttress reduction	-	Yes	Excellent	Union	< 6 months	1.Screw back out 2.Femoral neck shortening	none
2	752385	negative buttress reduction	Yes	-	Poor	Non Union	-	1. Non union 2. Screw back out	Total hip replacement
3	753495	negative buttress reduction	Yes	-	Excellent	Union	≥ 6 months	none	none
4	759014	positive buttress reduction	Yes	-	Good	Union	< 6 months	Screw backout	none
5	779225	anatomical reduction	-	Yes	Good	Union	< 6 months	AVN	none
6	780433	anatomical reduction	Yes	-	Excellent	Union	< 6 months	none	none
7	787277	anatomical reduction	Yes	-	Good	Union	< 6 months	AVN	none
8	795092	negative buttress reduction	Yes	-	Good	Union	≥ 6 months	none	none
9	794096	anatomical reduction	Yes	-	Excellent	Union	< 6 months	none	none
10	906327	anatomical reduction	Yes	-	Excellent	Union	≥ 6 months	none	none
11	904800	negative buttress reduction	-	Yes	Poor	Non Union	-	Non union	none
12	919271	negative buttress reduction	-	Yes	Poor	Non Union	-	Non union	Total hip replacement
13	847385	anatomical reduction	Yes	-	Reasonable	Union	≥ 6 months	Femoral neck shortening	none
14	926876	positive buttress reduction	Yes	-	Excellent	Union	≥ 6 months	none	none
15	957881	positive buttress reduction	Yes	-	Good	Union	≥ 6 months	AVN	none
16	748333	negative buttress reduction	Yes	-	Good	Union	≥ 6 months	Femoral neck shortening	none
17	941440	anatomical reduction	Yes	-	Good	Union	< 6 months	none	none
18	886466	positive buttress reduction	-	Yes	Reasonable	Union	≥ 6 months	AVN	Total hip replacement

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67

No. BFUHS/2K21p-TH/ 5064 Date 20/1/2021

The Principal,
DMC,Ludhiana.

Subject: **Approval of Plan of Thesis.**

This is to inform you that the Faculty of Medical Sciences in its meeting held on 22.01.2021 has approved the plan of thesis of **Dr. Udit Kumar,** a student of your college for **MS Orthopaedics** along with the names of Supervisor/Co-Supervisor as under:-

Topic Plan of Thesis
To study outcome of internal fixation of fracture neck of femur in adults

Supervisor
Dr. Harpal Singh Selhi
Prof.,
Dept. of Orthopaedics,
DMCH, Ludhiana.

Co-Supervisor
Dr. Deepak Jain
Prof.,
Dept. of Orthopaedics,
DMCH, Ludhiana.

The student has to submit the three copies of thesis (along with PDF format) , to the Controller of Examinations, BFUHS, Faridkot, at least six months before the commencement of theory examination, if he/she is otherwise eligible to take the examination. He /She must directed to attach a photocopy of this letter with the forwarding letter while submitting thesis to the University along with the letter of approval of University for change of supervisor/Co-Supervisor, change of topic,(if any).

Dr. S P Singh MS(Opth)
Controller of Examinations

Note :

1. ***If any discrepancy found regarding topic of thesis or Supervisor/Co-Supervisor, inform undersigned within one month after issue of this letter.***
2. *The student may submit the thesis as per the schedule already conveyed i.e for May/June examination 30th Nov of the preceding the year of examination and for Nov/Dec examinations 31st May of the year of examination.*

TO STUDY OUTCOME OF INTERNAL FIXATION OF FRACTURE NECK OF FEMUR IN ADULTS

THESIS PROPOSAL

FOR APPROVAL OF SUBJECT OF THESIS TO BE SUBMITTED

IN PARTIAL FULFILMENT OF THE REQUIREMENTS

FOR THE DEGREE OF

MASTER OF SURGERY

IN

ORTHOPEDICS

OF THE

BABA FARID UNIVERSITY OF HEALTH SCIENCES

FARIDKOT

NOVEMBER, 2019 **DR. UDIT KUMAR**

DEPARTMENT OF ORTHOPEDICS
DAYANAND MEDICAL COLLEGE AND HOSPITAL
LUDHIANA

ABSTRACT OF PLAN OF THESIS

Title	TO STUDY OUTCOME OF INTERNAL FIXATION OF FRACTURE NECK OF FEMUR IN ADULTS.
For the degree of	M.S. Orthopedics
Name of the candidate	Dr. Udit Kumar
Supervisor	Dr. Harpal Singh Selhi, Professor, Department of Orthopedics
Co-supervisor	Dr. Deepak Jain, Professor, Department of Orthopedics
Institution	Dayanand Medical College & Hospital, Ludhiana
University	Baba Farid University of Health Sciences, Faridkot

Introduction: Hip fractures are common, they comprise about 20 percent of orthopedic trauma. Femoral neck fractures almost account for 50 percent of all the fractures around hip.

Femoral neck fracture in young adults are uncommon and often result of high energy trauma. They are associated with higher incidence of femoral head osteonecrosis and nonunion. multiple factors play a significant role in preventing these devastating complications and contribute to a good outcome.

The aim of this study is to evaluate functional and radiological outcome of closed reduction and internal fixation of fracture neck of femur.

Aim of Study: To study "Functional and radiological outcome of internal fixation of fracture neck of femur in young adults using cannulated cancellous screw".

Materials & methods: Study will be conducted on inpatients in department of orthopedics in teaching hospital attached to Dayanand Medical College & Hospital, Ludhiana from May 2019 to Nov 2021 who have given valid informed consent to take part in the study. A structured pre designed proforma will be used for this study.

Clinical Significance: Femoral neck fractures are relatively uncommon in young adults with potentially serious long term complication. High rates of non union and avascular necrosis are seen after all types femoral neck fracture in young and with greater frequency in subcapital fractures.

Keywords: fracture neck of femur, cannulated cancellous screw, modified harris hip score.

(Signature)	(Signature)	(Signature)	(Signature)
Candidate	Co-supervisor	Supervisor	Principal

CERTIFICATE OF FACILITIES AVAILABLE

This is to certify that the facilities for work on the subject of thesis titled **"TO STUDY OUTCOME OF INTERNAL FIXATION OF FRACTURE NECK OF FEMUR IN ADULTS."** exist in the Department of Orthopedics, DMC&H, Ludhiana and will be provided to be candidate. We will see that the data being included in the thesis are genuine and is collected by the candidate himself under our supervision and guidance.

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HEAD OF DEPARTMENT

Dr. Rajnish Garg
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Department of Orthopedics
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Place: _____

Date: _____

APPROVAL PROFORMA
BY
RESEARCH & ETHICAL COMMITTEE
DAYANAND MEDICAL COLLEGE & HOSPITAL, LUDHIANA

Name of candidate	DR. UDIT KUMAR
Department	ORTHOPEDICS
Topic of Thesis	TO STUDY OUTCOME OF INTERNAL FIXATION OF FRACTURE NECK OF FEMUR IN ADULTS.
Likely date of appearing in PG examination	MAY 2022
Date of enrollment	MAY 16, 2019
Name of Head of Department	DR. RAJNISH GARG
1) **Supervisor** 2) **Co-Supervisor**	1) DR. HARPAL SINGH SELHI 2) DR.DEEPAK JAIN
Signature of Members of Research Committee with Stamp	**Signature of Members of Ethics Committee with Stamp**
Dr. Jaspal Singh (Professor & Head, Surgery)	Mr. A K Jindal (Member, Ethics Committee)
Dr. Dinesh Gupta (Professor & Head, Medicine)	Dr. Anu Sharma (Professor, Anatomy)
Dr. Sandeep Kaushal (Assistant Dean Academics)	Dr. Deepinder K Chhina (Professor & Head, Microbiology)
Dr. Rajoo Singh Chhina (Dean Academics)	Dr. Neena Sood (Professor & Head, Pathology)
Dr. Gurpreet S Wander (Vice Principal)	Dr. Gurpreet S Wander (Vice Principal)
	Dr. Gagandeep Singh (Secretary, Ethics Committee Professor & Head, Neurology)

Approved: Yes / ~~No~~

Dr. Sandeep Puri
Chairperson
Research Committee

Chairperson
Research Committee

Approved: Yes / ~~No~~

Prof. Arvind Malhotra
Chairperson
Ethics Committee

Chairperson
Ethics Committee

BABA FARID UNIVERSITY OF HEALTH SCIENCES, FARIDKOT

PROFORMA FOR REGISTRATION OF SUBJECT FOR DISSERTATION

1	NAME OF THE CANDIDATE AND ADDRESS	DR UDIT KUMAR WARD NO. 13, KOAT BAZAR, SITAMARHI, BIHAR
2	NAME OF THE INSTITUTE	DAYANAND MEDICAL COLLEGE AND HOSPITAL
3	COURSE OF STUDY AND SUBJECT	M.S. ORTHOPEDICS
4	DATE OF ADMISSION OF COURSE	16th MAY, 2019
5	TITLE OF THE TOPIC	TO STUDY OUTCOME OF INTERNAL FIXATION OF FRACTURE NECK OF FEMUR IN ADULTS.

6. BRIEF RESUME OF THE INTENDED WORK

6.1 NEED FOR THE STUDY

Most intracapsular femoral neck fractures occur in the elderly population. Femoral neck fractures in young patients are much less common and typically a result of a high-energy mechanism.[1] Between 3 and 10% of hip fractures occur in young patients after more severe forms of trauma such as motor vehicle accidents or falls from great height.[2] These injuries commonly occurred in the subcapital and basicervical regions, or as a vertical transcervical fracture. In contrast, most patients between 40 and 50 years of age were medically frail and sustained osteoporotic-type fractures during simple falls. The fracture pattern is more vertical (Pauwels III.50 degrees) and usually involves significant varus displacement.

Intracapsular fractures of femoral neck in the young adult are still regarded as unsolved fractures. Displaced fractures have more complications like nonunion and AVN of the femoral head.[1,3] The incidence of nonunion in a meta-analysis of studies in patients under the age of 60 years was 10% for displaced fractures and 5% in undisplaced fractures. Same meta-analysis also reported fixation failure in 9.7% of cases. Malunion of these fractures have been described in the coronal plane (coxa valga or coxa vara).[4] Malunion, higher functional demands and shortening after fracture healing leads to complication of limb length descripency which has higher rates in young population.[5]

When young patients sustain femoral neck fractures, all treatment decisions focus on preservation of the native femoral neck and head. Contemporary management controversies in these patients revolve around decreasing the rates of nonunion and avascular necrosis (AVN) of the femoral head, and include surgical timing, open versus closed reduction, and implant choices.[6]

The most important factor determining the outcome, is a good reduction as malreduction has greater chances of non union and avascular necrosis. High-velocity injury was no more crucial than low-velocity injury.

Therefore, goal for surgical treatment of femoral neck fractures in young patients is achieving union through an anatomic reduction and stable fixation while avoiding osteonecrosis. Time to surgery remains controversial. Advantages of early surgery include unkinking of vessels via urgent reduction and an intracapsular decompression, both intended to improve perfusion of the femoral head and thus, reduce the risk of osteonecrosis.

Internal fixation with cannulated cancellous (CC) screws after accurate reduction is the ideal method of treating femur neck fractures, as there is less blood loss, shorter operative time and less duration of hospital stay. The parallel screw fixation at present is considered as the standard of care and other modalities of treatment are compared with this technique.

We will conduct this study in our institute to evaluate functional outcome of patients with neck of femur fracture treated with cannulated cancellous (CC) screws. We will specially focus on the functional outcome.

6.2 REVIEW OF LITERATURE

Femoral neck fracture has been recognised since the time of Hippocrates (460-377 BC). The first description of hip fractures was by a French Surgeon Ambrose Pare in 1564. He did not clearly distinguish between a fracture and dislocation of hip. However Sir Astley Cooper gave a clear description of fracture of the neck of femur and other fractures and dislocations about the hip.[7]

In 1883 Nicholas Senn advocated closed reduction and impaction of fragments to achieve union of fracture. According to Senn "the only cause for non-union in case of an intracapsular fracture is our inability to maintain coaptation and immobilization of the fragments during the time required for the union to take place".[8]

Deyerlein et al, in 1980 noticed that multiple pins placed around the periphery of the femoral neck to compress the fracture provided rotatory stability, and he believed that this method would improve Osteosynthesis.[9]

Blair B, Koval K.J, Kummer F. et al., in 1994 showed that the preferred method of internal fixation with cannulated cancellous screws is that of an inverted triangle configuration of screw placement with first screw running along the calcar, second postero superiorly along the neck of femur, and a third screw antero superior as an additional support. This pattern also reduces the risk of stress fractures occurring at the level of lesser trochanter.[10]

Parker MJ and Guruswamy et al. in 2005 found no relationship between non-union of the fracture and position of the screws on the anteroposterior radiograph.[11]

Panteli et al., in 2005 reported conflicting evidence about screw number and position with no clear evidence supporting any particular screw number or configuration, although an inverted triangle configuration may be superior to other arrangements.[12]

The FAITH trial. The authors randomized 557 patients to have an SHS and 551 to have cannulated screws. There were 549 displaced fractures. Only patients in whom the surgeon felt that fixation was a better option than replacement were included; thus, for displaced

fractures, only younger patients with presumed good bone stock were included. Patients in whom replacement was felt to be the treatment of choice were excluded. The authors found that nonunions, implant failures, infections, fracture shortening, and fracture healing did not differ by surgical fixation approach, but there was a somewhat higher rate of AVN in the SHS group (9% for SHS vs. 5% for CS). However the primary study endpoint, hip reoperation within 24 months, did not differ by type of surgical fixation.[13]

Palm et al. described a posterior tilt angle measurement in Garden I and II fractures treated by internal fixation. On the lateral view, the angle is measured by drawing a line up the middle of the neck to the level of the fracture and then a line from the center of the femoral head to the fracture. If the angle subtended by these two lines was greater than 20 degrees on the preoperative radiograph, the reoperation rate at 1 year was significantly increased. This measurement may be a useful method of selecting patients with undisplaced fractures at higher risk of complications.[14]

Arnold et al recommended less than 20 degrees of posterior angulation to minimize the same complication. In relation to the reduction, the risk of AVN has been shown to be lowest with anatomic reduction. Either varus or valgus reductions increase the risk.[15]

Barnes et al. reported union in only 14- 5% of patients with displaced fractures at 6 months. Patients require regular radiographs until this time to ensure the fracture is uniting uneventfully. AVN tends to manifest itself after fracture union and is most common in the second year after injury.[16]

Loizou and Parker identified age of less than 60 years and female sex as factors associated with a higher risk of the complication.[17]

Haidukewych et al classified reduction as excellent (less than 2 mm displacement or less than 5 degrees angulation in any plane), good (2-5 mm displacement or 5-10 degrees angulation in any plane), fair 5-10 mm displacement and/or 10-20 degrees angulation in any plane) and poor reduction (more than 10 mm displacement and/ or more than 20

degrees angulation or any varus). According to both criteria, the reduction achieved in our patient was poor and unacceptable.[18]

6.3 AIMS AND OBJECTIVES

- To evaluate functional outcome of operatively managed fracture neck of femur with closed reduction and internal fixation with cannulated cancellous screw in young Indian adults using modified harris hip score.
- To study the complications of operative fixation of fracture neck of femur using cannulated cancellous screw.

7.0 MATERIALS AND METHODS

7.1 SOURCE OF DATA

Patients in department of orthopedics in teaching hospital attached to Dayanand Medical College & Hospital, Ludhiana from May 2019 to Nov 2020 who have given valid informed consent to take part in the study.

7.2 METHOD OF COLLECTION OF DATA

A. Methodology and type of data collected:

After obtaining clearance and approval from the institutional ethical committee, patients will be enrolled on the basis of the inclusion / exclusion criteria after obtaining informed consent.

Detailed history will be obtained from patient record using study proforma with special attention to mechanism of injury, evaluations including base line clinical features, examination of other associated symptoms will be based on history and physical examination.

Collection of data of patients presenting with fracture neck of femur are as follows.

- History.
- Clinical examination both systemic and local.
- Radiological examination using X ray, CT (computerized tomography) scan and other imaging modalities if necessary.
- Investigations – Routine and others.
- Diagnosis- Clinical and radiological.
- Surgery- closed reduction and internal fixation of fracture neck of femur using cannulated cancellous screw.
- Routine antibiotics and analgesics/anti-inflammatory drugs.
- Post operative evaluation by clinical examination and X ray hip with thigh (AP view, lateral view)

Assessment of complications:

- Immediate post-operative –Acute Renal Failure (ARF), pulmonary embolism, fat embolism, cardiovascular compromise (MI, ACS), infection, loss of reduction, DVT
- Late post-operative -infection, nonunion, malunion, failed fixation, osteoarthritis of hip joint, avascular necrosis of the femoral head, dislocation of femoral head, metal work failure.

Clinical follow-up will be done at 6 months intervals to assess the pain, healing of fracture, and functional status of the hip.

Radiological follow up by X ray will be done at 4 weeks, 3 months, 6months, to assess the reduction and healing status of the hip.

INCLUSION CRITERIA-

All fractures involving the neck of femur in patients between the age group of 18 - 50 years undergoing internal fixation

EXCLUSION CRITERIA

1. Age less than 18 years and those above 50 years.
2. Pre existing lesions of hip such as osteonecrosis of femoral head and degenerative arthritis
3. Concomittant disease affecting hip joint.
4. Neurological disorder like seizures, psychosis or mental deterioration.
5. Femoral neck fractures with severe posterior comminution.
6. Open fractures
7. Bullet injuries.
8. Pathological fractures
9. Fracture neck of femur associated with dislocation of head
10. Acetabular fracture
11. Polytrauma

Study design: Prospective

Duration of study: 1.5 Years

Place of study: Inpatients in Department of Orthopedics in teaching hospital attached to Dayanand Medical College & Hospital, Ludhiana.

Outcome: Final radiological and functional outcome at six months follow up using MODIFIED HARRIS HIP SCORE.

Statistical analysis: Data will be described in terms of range; mean ±standard deviation (± SD), frequencies (number of cases) and relative frequencies (percentages) as appropriate. All statistical calculations will be done using SPSS (Statistical Package for the Social Science) SPSS 21 version statistical program for Microsoft Windows.

7.3 DOES THE STUDY REQUIRE ANY INVESTIGATIONS OR INTERVENTIONS TO BE CONDUCTED ON PATIENTS OR OTHER HUMANS OR ANIMALS? IF SO, PLEASE DESCRIBE BRIEFLY.

- Investigations: Routine and others if required.
- Radiological examination using X ray, CT scan and other imaging modalities if necessary.

7.4 HAS ETHICAL CLEARANCE BEEN OBTAINED FROM YOUR INSTITUTION IN CASE OF 7.3?

Attached Herewith.

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PROFORMA

S.NO.

NAME: AGE: SEX:

MRD NO:

ADDRESS:

DATE OF INJURY:

DATE OF ADMISSION:

DATE OF DISCHARGE:

DATE OF OPERATION/ PROCEDURE:

MODE OF INJURY:

a) Trivial Trauma (fall)

b) Fall from moderate height

c) RTA

Personal and Family History :

a) Alcoholic / non-alcoholic

b) Smoker/non smoker

c) Vegetarian/Non vegetarian

d) Bladder and bowel habits : Normal/altered

LOCAL EXAMINATION:

a) MOVEMENTS OF HIP (Only active movements) :

b) Attitude of limb.

c) Level of A. S. I. S.

d) Swelling around proximal thigh/hip Yes/No

e) Skin changes.

Signature of Candidate **Signature of Supervisor**

X ray of the proximal third of femur including hip joint. (Anteroposterior view AND Lateral view)

a)Type of fracture :-

b)Site of Fracture:-

DATE OF SURGERY:

OPERATIVE TECHNIQUE :

Type of Fixation: Open/Closed

Implant Type:

Number of CCS used :

Arrangment of CCS :

Intra-operative complications :

POST OPERATIVE COMPLICATIONS:

Immediate: Retention of Urine

Swelling of operated limb

Any other complication:

Late: Wound infection: Superficial/deep

Deep vein thrombosis

Shortening or lengthening

Pulmonary embolism

Deformity

Signature of Candidate **Signature of Supervisor**

RADIOLOGICAL ASSESMENT OF REDUCTION:

Reverse S sign-

The Garden alignment index-

Radiological follow up: Union/Non Union

4 weeks	3 months	6 months

The modified harris hip score will be calculated at the final follow up after 6 months.

Signature of Candidate **Signature of Supervisor**

MODIFIED HARRIS HIP SCORE:-

Variable	Points
Pain	
None or ignores it	44
Slight, occasional	40
Mild pain, rarely moderate	30
Moderate pain	20
Marked pain	10
Totally disabled, pain in bed	0
Function	
Limp	
None	11
Slight	8
Moderate	5
Severe	0
Support	
None	11
Cane, long walks	7
Cane, most of the time	5
One crutch	3
Two canes	2
Two crutches	0
Not able to walk	0
Distance walked	
Unlimited	11
Six blocks	8
Two to three blocks	5
Indoors only	2
Bed and chair	0
Stairs	
Normally without railing	4
Normally with railing	2
In any manner	1
Unable to do	0
Shoes and socks	
With ease	4
With difficulty	2
Unable	0
Sitting	
Ordinary chair for 1 h	5
High chair for 1 h	3
Unable to sit in any chair	0
Public transport	
Able to use	1
Unable to use	0

Total Harris Hip Score: ____

Functional Result: ____

Signature of Candidate **Signature of Supervisor**

INFORMED PATIENT CONSENT

Date: _____

I.....D/o, W/o, S/o..... .....am willing to participate in the study **"TO STUDY OUTCOME OF INTERNAL FIXATION OF FRACTURE NECK OF FEMUR IN ADULTS."** The procedure with its complications has been explained to me in local vernacular language. I have fully understood that no special tests and extra expenditure in any form, merely for the purpose of thesis is being carried out. I am free to opt out the study any time without assigning any reason.

....

Signature of the Witness Signature of the patient

Name:

Signature of Candidate **Signature of Supervisor**

मरीज अनुमति फार्म

तिथि _____

मैं _____ पत्नी/पुत्र/पुत्री _____
निवासी

_____ इस शोधकार्य "TO STUDY OUTCOME OF INTERNAL FIXATION OF FRACTURE NECK OF FEMUR IN ADULTS." में भाग लेने के लिए सहमत हूँ। मैं इस शोधकार्य में भाग लेने के लिए अपनी स्वेच्छा से तैयार हूँ। मैं पुष्टि करता/करती हूँ की यह स्वीकृति देने के लिए मुझे कोई आर्थिक प्रलोभन नहीं दिया गया और न ही दबाव डाला गया है। मुझे इस शोधकार्य का उद्देश्य स्पष्ट कर दिया गया है और मुझे यह विश्वास है की यह विज्ञान और मानवता के लाभ के लिए है। मुझे इस शोधकार्य में होने वाले जोखिम के बारे में समझा दिया गया है और मेरी समझ में यह जोखिम बहुत मामुली है।

मैं इस शोधकार्य में भाग लेने के सम्बन्ध में किसी भी समय अपनी अस्वीकृति व्यक्त कर सकता/सकती हूँ और मेरे अस्वीकृति व्यक्त करने का मेरे इलाज पर कोई प्रभाव नहीं पड़ेगा।

_____
गवाह के हस्ताक्षर
नाम:

_____
रोगी के हस्ताक्षर/अंगूठे का निशान
नाम:

_____
अन्वेषक के हस्ताक्षर

_____
विद्यार्थी के हस्ताक्षर

ਮਰੀਜ਼ ਰਜ਼ਾਮੰਦੀ ਫਾਰਮ

ਮਿਤੀ_____

ਮੈ_____ਪਤਨੀ/ਪੁੱਤਰ/ਪੁੱਤਰੀ_____

ਵਾਸੀ _____

"TO STUDY OUTCOME OF INTERNAL FIXATION OF FRACTURE NECK OF FEMUR IN ADULTS." ਤੇ ਚਲ ਰਹੀ ਖੋਜ ਵਿਚ ਹਿੱਸਾ ਲੈਣ ਲਈ ਰਜ਼ਾਮੰਦ ਹਾਂ। ਇਸ ਖੋਜ ਕੰਮ ਵਿਚ ਹਿੱਸਾ ਲੈਣ ਲਈ ਮੈ ਆਪਣੀ ਮਰਜ਼ੀ ਨਾਲ ਤਿਆਰ ਹਾਂ। ਮੈ ਇਹ ਦਸਣਾ ਚਾਹੁੰਦਾ ਹਾਂ/ ਚਾਹੁੰਦੀ ਹਾਂ ਕੇ ਇਹ ਰਜ਼ਾਮੰਦੀ ਦੇਣ ਵਾਸਤੇ ਮੈਨੂ ਕਿਸੇ ਵੀ ਤਰਾਂ ਦਾ ਲੋਭ-ਲਾਲਚ ਨਹੀ ਦਿੱਤਾ ਗਿਆ ਅਤੇ ਨਾ ਹੀ ਕੋਈ ਦਬਾ ਪਾਇਆ ਗਿਆ ਹੈ। ਮੈਨੂ ਇਸ ਖੋਜ ਦਾ ਮਨੋਰਥ ਸਮਝਾ ਦਿੱਤਾ ਗਿਆ ਹੈ ਅਤੇ ਮੈਨੂ ਇਹ ਭਰੋਸਾ ਦਵਾਇਆ ਗਿਆ ਹੈ ਕੇ ਇਹ ਖੋਜ ਵਿਗਿਆਨ ਅਤੇ ਮਾਨਵਤਾ ਦੀ ਭਲਾਈ ਲਈ ਹੈ। ਮੈਨੂ ਇਸ ਖੋਜ ਵਿਚ ਹੋਣ ਵਾਲੇ ਖਤਰੇ ਬਾਰੇ ਸਮਝਾ ਦਿੱਤਾ ਗਿਆ ਹੈ ਅਤੇ ਮੈਨੂ ਇਹ ਯਕੀਨ ਹੈ ਕੇ ਇਹ ਖਤਰਾ ਬਹੁਤ ਮਾਮੂਲੀ ਹੈ। ਮੈਨੂ ਇਸ ਖੋਜ ਕੰਮ ਵਿਚ ਹਿੱਸਾ ਲੈਣ ਦਾ ਢੰਗ – ਤਰੀਕਾ ਸਮਝਾ ਦਿੱਤਾ ਗਿਆ ਹੈ।

ਮੈ ਇਸ ਖੋਜ ਕੰਮ ਵਿਚ ਹਿੱਸਾ ਲੈਣ ਬਾਰੇ ਆਪਣੀ ਰਜ਼ਾਮੰਦੀ ਕਿਸੇ ਵੀ ਸਮੇ ਵਾਪਸ ਲੈ ਸਕਦਾ ਹਾਂ/ ਸਕਦੀ ਹਾਂ ਅਤੇ ਮੇਰੀ ਰਜ਼ਾਮੰਦੀ ਵਾਪਸ ਲੈਣ ਦਾ ਮੇਰੇ ਇਲਾਜ ਤੇ ਕੋਈ ਅਸਰ ਨਹੀ ਹੋਵੇਗਾ।

_____ _____

ਗਵਾਹ ਦੇ ਹਸਤਾਖਰ ਮਰੀਜ਼ ਦੇ ਹਸਤਾਖਰ

ਮਿਤੀ_____ ਮਿਤੀ_____

ਪਤਾ _____ ਪਤਾ _____

_____

ਨਿਰੀਖਕ ਦੇ ਹਸਤਾਖਰ

_____

ਸਿਖਿਆਰਥੀ ਦੇ ਹਸਤਾਖਰ